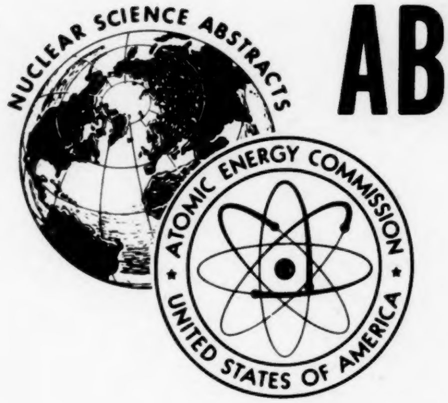
NUCLEAR SCIENCE ABSTRACTS



Volume 26 Number 17

Abstracts 40565-42689

September 15, 1972

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Volume 26, Number 17, September 15, 1972

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Personal Authors

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NEWCOMB, William A., Stability of a magnetic well, 25:1239
NEWKIRK, L. R., Superconductivity in the pseudobinary
  alloys V_3Si--Nb_3Al, 25:1093 (CALT-822-13)
NEWLAND, E. A., Radiation treatment of sewage, 25:140
  (AAEC/LIB/Bib-254)

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TRANSURANIUM ELEMENTS
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  25:40 (IDO-12073, pp 28-36)
separation by ion exchange and complex-formation elution,
  25:251(P)
TRIETHYLENETETRAMINE
complexes with cobalt(III) and rhodium(III) chlorides,
  radiation effects on labeled, thermal-neutron, 25:137
TRITIUM
content in Cattaraugus Creek near West Valley Processing
  Plant, July through Dec. 1969, 25:258 (DOCKET-50201-
  48)
content in Cattaraugus Creek near West Valley Processing
  Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
determination in luminescent material by scintillation
  ccunting, 25:40 (IDO-12073, pp 28-36)

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Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009-1). Dep. NTIS.

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

40565 (AEC-tr-7223/5-6) NUKLEONIKA. Translation of Nukleonika; 16: No. 5-6, 191-310(1971). 111p. (TT-70-55104/5-6). Dep. NTIS.

Analytical Chemistry

Refer also to abstracts 40742, 40822, 40824, 40937, 40939, and 40940.

40566 TREATISE ON ANALYTICAL CHEMISTRY. PART I. THEORY AND PRACTICE. VOLUME 10. Kolthoff, I. M.; Elving, Philip J. (eds.). New York; John Wiley and Sons, Inc. (1972). 611p. $24.95.

Six chapters are included in the three sections on application of measurements (continued from the previous volume), principles of instrumentation, and preparation for analytical research and utilization. Separate abstracts were prepared for three of the chapters. The remaining three include discussions of gas analysis: thermal conductivity; general concepts of instrumentation for chemical analysis, and the literature of analytical chemistry. A subject index is also included. (J.G.B.)

For abstracts of individual chapters see: 40567, 40568, and 40615.

40567 GAS ANALYSIS: DETERMINATION OF GASES IN METALS. Horton, William S. (National Bureau of Standards, Washington, D. C.); Carson, Chester C. pp 6017-6144 of Treatise on Analytical Chemistry. Part I. Theory and Practice. Volume 10. /Kolthoff, I. M. (ed.). New York; John Wiley and Sons, Inc. (1972).

Various physical and chemical methods are reviewed. Vacuum methods include mercury amalgamation, vacuum heating, distillation, hot extraction and determination of hydrogen, vacuum-fusion analysis, isotopic methods, and microprobe techniques. Activation methods, inert gas fusion and extraction, and spectrographic methods are also reviewed. Specific spectrographic methods of analysis are considered for iron and steel, Ti, Zr, V, Nb, La, and Y. (289 references). (J.G.B.)

40568 DESIGN OF EXPERIMENTS IN ANALYTICAL CHEMISTRY INVESTIGATION. Tingey, Fred H. (Aerojet Nuclear Co., Idaho Falls, Idaho). pp 6405-93 of Treatise on Analytical Chemistry. Part I. Theory and Practice. Volume 10. /Kolthoff, I. M. (ed.). New York; John Wiley and Sons, Inc. (1972).

The following topics are discussed: definition and notation; models; experimental design, including preliminary considerations, simple comparative experiments, and factorial experiments; testing hypotheses; and analysis of variance. An appendix is included with examples, including an experiment performed relative to the determination of TBP in a uranyl nitrate solution, a colorimetric determination of U, determination of radioactive iodine in off-gases, recovery of U from spent reactor fuels, the preparation of "hot" uranyl nitrate solutions for analysis, and the determination of U in uranyl nitrate solutions by isotope dilution. (24 references). (J.G.B.)

Activation and Nuclear Reaction Procedures

Refer also to abstracts 41311, 41476, and 42602.

40569 (CSIRO-Trans-10704) SELECTIVITY OF GAMMA-ACTIVATION ANALYSIS. Davydov, H. G.; Shcherbachenko, V. A. Translated by G. Hitoun (Commonwealth Scientific and Industrial Research Organization), from At. Energ. (USSR); 27: No. 3, 205-8(Sep 1969). 6p. Dep. NTIS (U. S. Sales Only).

An abstract of this article prepared from the original appeared as NSA 23: 47412 (1969). (Australia)

40570 (EURISOTOP—57) DETERMINATION OF OXYGEN, SILICON, PHOSPHORUS, AND COPPER IN IRON AND STEEL BY 14-MeV NEUTRON ACTIVATION ANALYSIS. Van Grieken, R.; Gijbels, R.; Speecke, A.; Hoste, J. (Ghent Rijksuniversiteit (Belgium)). Dec 1971. 95p. Dep. NTIS (U. S. Sales Only).

Neutron activation methods for the determination of Si in steel, Si and P in cast iron, and the simultaneous determination of O, Si, P, and Cu in iron and steel are discussed. Sensitivity of the 14-MeV neutron activation determination of Si in steel is estimated at 0.02 to 0.05%, dependent on the P content. A precision of 3% was obtained at >1% Si content; 7% precision was obtained at 0.1% Si. An internal standard method was used for the higher precision necessary in the analysis of magnetic steels. The fast, nondestructive 14-MeV neutron method for simultaneous determination of Si and P in cast iron is suitable only for high phosphorus steels. A fast, nondestructive simultaneous determination of Si, O, P, and Cu in iron and steel is also discussed. (J.G.B.)

40571 (EURISOTOP—65) ANNOTATED BIBLIOGRAPHY ON 14-MeV NEUTRON ACTIVATION ANALYSIS. Van Grieken, R.; Hoste, J. (European Atomic Energy Community, Brussels (Belgium). Bureau Eurisotop). 1972. 295p. Dep. NTIS (U. S. Sales Only).

The 820 references included cover the literature through 1971. Only those articles are included that deal directly with activation analysis by ^{3}H(^{2}H,n)^{4}He neutrons. Author, element determined, matrix analyzed, and techniques used and miscellaneous indexes are included. (M.C.G.)

40572 RADIATIVE-NEUTRON-CAPTURE GAMMA-RAY ANALYSIS BY A LINEAR COMBINATION TECHNIQUE. Tanner, A. B. (Geological Survey, Washington, D. C.); Bhargava, R. C.; Senftle, F. E.; Brinkerhoff, J. M. Nucl. Instrum. Methods; 102: No. 1, 61-72(1972).

The linear combination technique, when applied to a γ spectrum, gives a single number indicative of the extent to which the spectral lines of a sought element are present in a complex spectrum. Spectra are taken of the sought element and of various other substances whose spectra interfere with the spectrum of the sought element. A weighting function is then computed for application to spectra of unknown materials. The technique was used to determine calcium by radiative-neutron-capture gamma-ray analysis in the presence of interfering elements, notably titanium, and the results were compared with those for two popular methods of peak area integration. Although linearity of response was similar for the methods, the linear combination technique was much better at rejecting interferences. For analyses involving mixtures of unknown composition the technique consequently offers improved sensitivity. (auth)

40573 ACTIVATION ANALYSIS OF SOME LIGHT ELEMENTS USING PROTONS IN NUCLEAR REACTIONS. Mazitov, B. S.; Muminov, V. A.; Mukhamedov, S.; Sultanov, B. (Inst. of

Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 4, 73-7(1971). (In Russian).

The use of (p,α), (p,n), (p,pn), and (p,γ) reactions was evaluated for activation analysis for the determination of the light elements O, N, C, F, and B. For each reaction the optimum proton energy, sensitivity, and interfering nuclear reactions are tabulated. (15 references) (K.S.W.)

40574 SKELETON STRUCTURE OF NICKEL CATALYSTS AND RADIOACTIVE METHODS OF THEIR ANALYSIS. Sattarov, M. G.; Nalibaev, T. N. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 4, 78-82 (1971). (In Russian).

Samples of Ni–Al catalysts were irradiated with 14.5-MeV neutrons from a T(d,n)^{4}He generator and the induced radioactivity was analyzed with a universal scintillation detector using a NaI (Tl) crystal. In particular, determinations of Mo and Fe were required from two types of alloys: Ni–Mo–Al and Ni–Fe–Al. The results of radioactivation methods of analysis are compared with those from chemical analyses. (K.S.W.)

40575 NEUTRON ACTIVATION ANALYSIS FOR ALUMINUM IN BONE SAMPLES. Gilmore, G. R.; Goodwin, B. L. (Universities Research Reactor, Risley, Eng.). Radiochem. Radioanal. Lett.; 10: No. 4, 217-22(10 Jun 1972).

A convenient method for the neutron activation determination of aluminum in phosphate-containing biological samples was developed. A pre-irradiation ion exchange separation of Al is followed by activation on the column. The method was applied principally to bone ash. (auth)

40576 RAPID DETERMINATION OF TUNGSTEN IN ROCKS USING ^{183m}W. Zinner, H.; Henkelmann, R.; Staerk, H. (Technische Univ., Munich). Radiochem. Radioanal. Lett.; 10: No. 4, 191-200(10 Jun 1972).

A rapid method was developed for the determination of tungsten in rocks. The reaction ^{182}W(n,γ)^{183}W with a thermal neutron capture cross section of 0.5 barn was used, irradiating the samples in the fast pneumatic system of the FRM. The low-energy γ-rays and x rays of the isomer ^{183m}W (5.3-sec) were measured by a Ge(Li) detector. The sensitivity of the method is 0.1 mg W with an accuracy of about 5%. Analysis time is 2 min per sample. (auth)

40577 LARGE-SCALE STUDY OF PAPER BY NEUTRON ACTIVATION ANALYSIS. Schlesinger, H. L.; Settle, D. M. (Gulf Energy and Environmental Systems Co., San Diego, Calif). Contract AT(04-3)-167. J. Forensic Sci.; 16: No. 3, 309-30 (Jul 1971).

The value of nondestructive thermal neutron activation analysis (TNAA) in the problem of characterizing paper was investigated. It was concluded that, if the data obtained are applicable to the entire population of bond paper samples, it would be possible to identify the most probable source of a given paper sample by TNAA to a rather high degree of probability. (D.H.M.)

40578 NEUTRON ACTIVATION ANALYSIS OF COPPER BY SUBSTOICHIOMETRIC EXTRACTION WITH NEOCUPRIONE. Nadkarni, R. A.; Haldar, B. C. (Inorganic and Nuclear Chemistry Lab., Bombay). Anal. Chem.; 44: No. 8, 1504-6(Jul 1972).

A method for determining trace amounts of copper in biological and geological materials is presented that is based on neutron activation and substoichiometric extraction of copper with neocuproine in chloroform. Five samples containing the same amounts of copper were extracted by the procedure given, and the replicate results were found to agree within ±1.84 relative percent at 95% confidence limits. (D.H.M.)

40579 COMPARISON OF NEUTRON ACTIVATION ANALYSIS AND OTHER ANALYSES PROCEDURES FOR FISH SAMPLES. Eckhoff, N. D.; Pappas, C. J.; Deyoe, C. W. (Kansas State Univ., Manhattan). Anal. Chem.; 44: No. 8, 1506-8(Jul 1972).

A method of neutron activation analysis of fish samples for estimates of K, Ca, Mn, Cl, and Na is presented. Since not all the γ-ray spectral data are needed for a precise, nondestructive analysis of a sample and therefore large quantities of data need not be manipulated, an area-of-interest least square method is described that saves computer time. Results from this neutron activation method are compared with atomic absorption and colorimetric analysis of three fish bone and three total fish ash samples. (D.H.M.)

40580 DETERMINATION OF TRACE QUANTITIES OF URANIUM IN BIOLOGICAL MATERIALS BY NEUTRON ACTIVATION ANALYSIS USING A RAPID RADIOCHEMICAL SEPARATION. Becker, Donald A.; LaFleur, Philip D. (National Bureau of Standards, Washington, D. C.). Anal. Chem.; 44: No. 8, 1508-11(Jul 1972).

A neutron activation method for determining trace amounts of uranium in various materials at levels of 10^{-6} and 10^{-9} is demonstrated using solvent extraction from strong acid solutions with hydrogen bis(2-ethylhexyl) phosphate. The materials analyzed included orchard leaves, beef liver, zirconium metal, and copper oxide single crystals. The total time required for the analysis of triplicate samples ranged from 30 to 60 min excluding the calculation of results. (D.H.M.)

40581 NONDESTRUCTIVE CHARGED PARTICLE ACTIVATION ANALYSIS USING SHORT-LIVED NUCLIDES. Deburn, Jean-Luc; Riddle, David C.; Schweikert, Emile A. (Texas A and M Univ., College Station). Anal. Chem.; 44: No. 8, 1386-91(Jul 1972).

The objective of this study was to combine the features of nondestructive determination with speed of analysis. Accordingly, this study was restricted to radioisotopes with half-lives ranging from 1 second to ~1 minute. Furthermore, only those species were considered which emit one or several γ rays besides the 511-keV annihilation peak. Thirty elements were irradiated with protons or ^{3}He particles. Activation with ^{3}He proved to be of little interest in the cases studied. Proton activation was found suitable for the trace determination of the following elements: Se, Br, Y, Zr, La, Pr, Dy, and Nd. Data on their respective specific activities, activation curves, and pertinent γ energies (±0.3 · keV) are given. These elements can be determined in 13 matrix elements which yield little or no activity under the experimental conditions described. Among these are matrices where neutron activation analysis cannot be applied easily because of high neutron absorption or activation cross sections. (auth)

40582 DETERMINATION OF MERCURY IN PHARMACEUTICAL PRODUCTS BY NEUTRON ACTIVATION ANALYSIS. Margosis, Michel; Tanner, James T. (Dept. of Health, Education, and Welfare, Washington, D. C.). J. Pharm. Sci.; 61: No. 6, 936-8(Jun 1972).

A reliable, efficient, and highly specific method is presented for the determination of mercury in pharmaceutical products. Neutron activation analysis is used for the elemental determination of various organomercurials and requires no chemical separation or cleanup. The induced radioactivity of ^{197}Hg and ^{203}Hg is the basis of this method. Recoveries ranged as follows: neutron activation analysis (14 samples), 90 to 108% (^{197}Hg) and 91 to 110% (^{203}Hg); x-ray fluorescence (10 samples), 91 to 101%; atomic absorption (nine samples), 84 to 112%; and cold vapor atomic absorption (four samples), 106 to 121%. (auth)

40583 RAPID METHOD OF NEUTRON ACTIVATION ANALYSIS FOR ASSESSMENT OF TRACE ELEMENTS IN SERUM. Samsahl, K. (Gesellschaft fuer Strahlen- und Umweltforschung, Neuherberg, Ger.); Schramel, P.; Thieme, R.; Klose, B.-J. Nucl.-Med.; 11: No. 1, 79-89(15 May 1972). (In German).

A rapid method, to a large degree automatized, is described, which gives reasonable mean values of a large series of samples within a short period of time. The method is applicable for routine analysis in clinical medicine. Samples of blood serum are obtained and irradiated, group separation of elements carried out and γ spectroscopic measurements made. The elements Ca, Co, Cu, Fe, Mo, Na, Rh, W, and Zn were determined. (M.C.G.)

40584 INVESTIGATION OF ANOMALOUS WATER BY NEUTRON ACTIVATION ANALYSIS. Spitsyn, Vikt. I; Glazunov, M. P.; Mulyar, V. M.; (and others) (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 202: No. 1, 132-5 (Jan 1972). (In Russian).

Samples of anomalous water prepared by different methods were subjected to neutron activation analysis. Only impurities such as silicon and sodium (from the quartz vessels employed) were detected, and these two impurities were present in much higher concentrations than in twice-distilled water that was tested under identical conditions. (K.S.W.)

40585 ANALYTICAL INSTRUMENTATION IN THE FORENSIC SCIENCES. Ulrich, W. F.; Stine, K. S.; Blecha, D. L.; Harms, D. R. Fullerton, Calif.; Beckman Instruments, Inc. (1971). 91p. $5.00.

This manual is a guide to the role of analytical instrumentation in solving the problems of forensic science. Techniques discussed are: gas-liquid chromatography, ir and uv spectrophotometry, Raman spectroscopy, spectrofluorometry, spectropolarimetry, spectroreflectometry, nuclear magnetic resonance, electron spin resonance, x-ray diffraction, mass spectroscopy, thermoluminescence, emission spectroscopy (optical), atomic absorption spectroscopy, x-ray spectroscopy, neutron activation analysis, liquid scintillation counting, thinlayer chromatography, electrophoresis, potentiometry, voltammetry, thermal techniques, and automated systems. Details are given on the use of gas chromatography, ir and uv spectrophotometry, and Raman spectroscopy for the identification of barbiturates, amphetamines, hallucinogens, narcotics, and other drugs. (J.G.B.)

40586 TRACE SUBSTANCES IN ENVIRONMENTAL HEALTH. V. Proceedings of University of Missouri's 5th Annual Conference, Columbia, Missouri, June 29–July 1, 1971. Hemphill, Delbert D. (ed.). Columbia, Missouri; University of Missouri (1972). 575p. (CONF-710645).

Separate abstracts were prepared for 6 of the 46 papers presented. The papers that were out of NSA scope concerned epidemiology; environmental pollution; metabolic effects of trace substances; health effects of trace substances; analytical methodology; and geochemical and geographical relationships of health and disease. (D.H.M.)

For abstracts of individual papers see: 40587–40590, 40616, and 40617.

40587 CHEMICAL ANALYSIS OF THE INTACT HUMAN BEING. Lenihan, J. M. A. (Western Regional Hospital Board, Glasgow). pp 375-82 of Trace Substances in Environmental Health. V. /Hemphill, Delbert D. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From fifth annual conference on trace substances in environmental health; Columbia, MO. (29 Jun 1971). See CONF-710645.

The Occupancy Principle, a simple but powerful theorem of recent origin, allows estimation of the total amount of certain elements in the whole body, or in particular organs, to be calculated from isotopic tracer tests of the traditional kind reinforced by activation analysis of tissue samples in vitro. The technique which (in contrast to in vivo neutron activation) involves no significant radiation dosage to the patient, also yields daily intake levels without the necessity for sampling or analysis of the diet. The proportion of dietary intake which is absorbed from the gut can also be determined. This technique, which has already been used in the estimation of thyroid stable iodine, total body bromine and total body rubidium, is being extended to deal with other elements, including mercury, selenium and others of interest in relation to environmental health. (auth)

40588 DISTRIBUTION OF ZINC, CADMIUM, AND MERCURY IN THE HUMAN KIDNEYS. Livingstone, Hugh D. (Bowman Gray School of Medicine, Winston-Salem, N. C.). pp 399-411 of Trace Substances in Environmental Health. V. /Hemphill, Delbert D. (ed.). Columbia, Mo.; Univ. of Missouri (1972).

From fifth annual conference on trace substances in environmental health; Columbia, MO. (29 Jun 1971). See CONF-710645.

Simultaneous analyses of human kidney cortex tissues for zinc, cadmium, and mercury were made by neutron activation combined with either, radiochemical separation prior to counting, or direct germanium detector gamma spectrometry. For some adult and infant samples, analyses were made on successive tissue slices from the outer cortex of the inner medulla. Zinc and cadmium show a concentration gradient with the highest concentrations at the outer medulla. Mercury was preferentially concentrated deeper in the cortex. All three metals, and especially cadmium, are found in higher concentrations in adult compared to infant kidneys. A mechanism for the rapid increase in renal cadmium is proposed. The heterogeneous renal distribution of the elements indicates that careful sampling is necessary in any comparative study of their occurrence in human kidney tissue. (auth)

40589 NEUTRON ACTIVATION ANALYSIS: APPLICATION TO TRACE ELEMENT ANALYSIS IN BIOLOGICAL AND ENVIRONMENTAL MATERIALS. Becker, Donald A.; LaFleur, Philip D. (National Bureau of Standards, Washington, D. C.). pp 447-53 of Trace Substances in Environmental Health. V. /Hemphill, Delbert D. (ed.). Columbia, Mo.; Univ. of Missouri (1972).

From fifth annual conference on trace substances in environmental health; Columbia, MO. (29 Jun 1971). See CONF-710645.

Neutron activation analysis (NAA) has been found useful for trace element analysis of biological and environmental samples. The favorable characteristics of this technique include high sensitivity, wide applicability, great specificity, and reduced contamination and reagent blank problems. The utilization of this technique for the analysis of several elements (Mn, Na, Cu, Zn, U) in the recently certified NBS Biological Standard Reference Material: orchard leaves, is described. Techniques used include both nondestructive analysis and destructive analysis using radiochemical separations. In addition, the analytical results obtained by NAA on the Orchard Leaves are compared to that obtained by other analytical techniques. (auth)

40590 SOME SENSITIVITIES OF SOME HEAVY METALS IN TYPICAL ENVIRONMENTAL MATRICES. Eckhoff, N. D.; Ervin, P. F.; Clack, R. W.; Lambert, J. P. (Kansas State Univ., Manhattan). pp 455-62 of Trace Substances in Environmental Health. V. /Hemphill, Delbert D. (ed.). Columbia, Mo.; Univ. of Missouri (1972).

From fifth annual conference on trace substances in environmental health; Columbia, MO. (29 Jun 1971). See CONF-710645.

Selection of an analysis technique is often based on its sensitivity. Because of the low allowable environmental concentrations for many heavy metals, experimental (as contrasted to calculated) sensitivities for these metals in environmental matrices are important to the analyst in selecting the best analysis procedure. Sensitivities for the analysis of heavy metal elements by neutron activation analysis (NAA) are generally calculated on an interference-free basis. These calculated results are presented for comparison purposes. However, the more important sensitivities for heavy metals in interference matrices such as water, air filters, and biological materials are calculated using 10% statistics, i.e., a 10% fractional error. The TRIGA nuclear reactor source was used in these sensitivity calculations. From these results it is readily apparent that NAA is well-suited for some heavy metal analyses; while only moderately good for others; and inadequate for others, e.g., Pb. (auth)

40591 FISSIONABLE MATERIAL DETERMINATION IN FUEL ELEMENTS BY MEANS OF DELAYED NEUTRONS. Eberle, R.; Krappel, W.; Stegemann, D.; Zeller, M. (Technische Univ., Hanover). pp 662-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A short pulse of primary neutrons (D−T) is emitted onto the fuel element. The delayed neutrons are recorded by a sensitive detector arrangement. The response signal of the delayed neutrons is compared with a response signal from a reference element with the same geometry. Data acquisition and evaluation and first results are given. (INIS)

40592 QUANTITATIVE ANALYSIS OF Mg, Na, Cl, Al, AND Ca IN HUMAN DENTAL CALCULUS BY NEUTRON ACTIVATION ANALYSIS AND HIGH RESOLUTION GAMMA-SPECTROMETRY. Retief, D. H.; Cleaton-Jones, P. E.; Turkstra, J.; Smit, H. J.; Pretorius, P. J. (Univ. of the Witwatersrand, S. Afr. South African Medical Research Council, Johannesburg. Atomic Energy Board, Pretoria). J. Dent. Res.; 51: No. 3, 807-11(1972).

The concentrations of magnesium, sodium, chlorine, aluminum, and calcium in pooled human dental calculus dried to constant weight at 105°C were determined by instrumental neutron activation analysis. Their mean concentrations were 0.50 ± 0.04%, 0.37 ± 0.03%, 0.09 ± 0.01%, 96.08 ± 14.63 ppM, and 28.04 ± 1.70%, respectively. (auth)

Chemical and Spectral Procedures

Refer also to abstracts 40865 and 40996.

40593 (RISO–251) ASSAY OF POWDERED METALLIC ORES BY MEANS OF A PORTABLE X-RAY FLUORESCENCE ANALYSER. Kunzendorf, H.; Loevborg, L.; Wollenberg, H. (Danish Atomic Energy Commission, Risoe. Research Establishment). Nov 1971. 29p. Dep. NTIS (U. S. Sales Only).

Radioisotope x-ray fluorescence analysis of powdered metallic ores was carried out by means of a portable instrument. Description of and experience with this instrument are included. Elements investigated were Cr, Ni, Cu, Zn, Zr, Nb, Mo, La plus Ce, and Pb. Typical powdered ore minerals of these elements were mixed with powdered material of granitic or gabbroic composition, and calibration curves were established by plotting the difference count rates obtained by means of the portable x-ray fluorescence analyzer against the contents of the elements in the mixtures. Regression analysis of the lower linear part of these curves yielded detection limits and accuracies, both of the order of 0.1%. (auth)

40594 LASER-EXCITED ATOMIC FLUORESCENCE FLAME SPECTROMETRY AS AN ANALYTICAL METHOD. Fraser, L. M.; Winefordner, J. D. (Univ. of Florida, Gainesville). Anal. Chem.; 44: No. 8, 1444-51(Jul 1972).

A pulsed, tunable dye laser pumped with an N_2-laser is used to excite atomic fluorescence of Al, Ca, Co, Cr, Ga, In, Fe, Mn, Mo, Ni, Sr, Ti, and Tl in H_2−air, C_2H_2−air, and C_2H_2−N_2O flames. Laser-excitation has several advantages over conventional continuously operated line or continuum sources; only one source is needed; freedom from flame background and analyte emission interferences; and the simplicity of using nonresonance fluorescence to eliminate noise due to scatter of exciting radiation from particles within the flame gases. In addition to resonance fluorescence, excited state resonance fluorescence, Stokes direct line fluorescence, and excited state anti-Stokes direct line fluorescence are shown to be analytically useful. Limits of detection and range of linearity of analytical curves are given for each element. (auth)

40595 USE OF INDUCTION FURNACE SOURCE FOR SPECTROMETRIC DETERMINATION OF IODINE. Talmi, Yair; Morrison, G. H. (Cornell Univ., Ithaca, N. Y.). Anal. Chem.; 44: No. 8, 1467-9(Jul 1972).

The use of the RF induction furnace (RFF) source for determining iodine in various samples by atomic emission at the 2062 Å spectral line was investigated. The iodine detection limit was 10 ng. (D.H.M.)

40596 DIRECT ISOTOPIC DETERMINATION BY ATOMIC FLUORESCENCE SPECTROMETRY. Veillon, Claude; Park, John Y. (Univ. of Houston, Tex.). Anal. Chem.; 44: No. 8, 1473-6(Jul 1972).

The use of atomic fluorescence spectroscopy for isotopic determination was investigated. From results of the determination of the isotopes of mercury, indium, zinc, and copper it was concluded that direct isotopic determination by atomic fluorescence spectrometry employing flame atomization cells is limited to elements having relatively large isotopic displacements, because of Doppler broadening of the isotopic absorption lines in the flame cell. Methods for overcoming this limitation are suggested. (D.H.M.)

40597 DETERMINATION OF METALLIC-ELEMENT IMPURITIES IN URANIUM HEXAFLUORIDE BY SPARK SOURCE MASS SPECTROMETRY. Howard, Olin H. (Union Carbide Corp., Oak Ridge, Tenn.). Anal. Chem.; 44: No. 8, 1482-4(Jul 1972).

A spark source mass spectrometric method for determining impurities in uranium hexafluoride is presented that allows approximately 35 elements of interest to be determined to 1 ppM or less, with an average relative standard deviation of ±33% and an analysis time of 5 hours. The uranium hexafluoride is converted to uranium oxide (U_3O_8) and compressed with silver powder for the analysis. (D.H.M.)

40598 ULTRASONIC VELOCITY IN WATER-DEUTERIUM OXIDE MIXTURES: A BASIS FOR DEUTERIUM DETERMINATION IN SOLUTIONS. Mathieson, J. G.; Conway, B. E. (Univ. of Ottawa). Anal. Chem.; 44: No. 8, 1517-20(Jul 1972).

A method for in situ direct H_2O-D_2O analysis using ultrasonic velocity measurements is described that can be applied to the determination of D following enrichment of H_2O or determination of H following adventitious dilution of D_2O in reactor fluids. Examination of the ultrasonic velocity data obtained in dilute solutions shows that satisfactory measurements can be made down to 0.015% H in D_2O or 0.015% D in H_2O, i.e., ca. 0.01 mole/l HOD. (D.H.M.)

40599 FLUORIMETRIC DETERMINATION OF RUTHENIUM USING 1,10-PHENANTHROLINE. Shcherbov, D. P.; Gladysheva, G. P.; Ivankova, A. I. (Inst. of Mineral Raw Materials, Alma-Ata, USSR). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 11, 1665-7(Nov 1971).

Translated from Zavod. Lab.; 37: No. 11, 1300-3(Nov 1971).

Reactions involved in the fluorescence determination of ruthenium using 1,10-phenanthroline were studied. The effects of 1, 10-phenanthroline and hydroxylamine content, pH of the medium, and duration of heating of the solution are discussed. Absorption and emission spectra are given. A modified method was found to be effective for the elimination of interference from Fe, Ni, Cu, and Bi. (J.G.B.)

40600 PHOTOMETRIC DETERMINATION OF TELLURIUM IN ATMOSPHERIC AIR. Alekseeva, L. S.; Murashova, V. I.; Bakunina, L. I.; Skripchuk, V. G. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 11, 1663-4(Nov 1971).

Translated from Zavod. Lab.; 37: No. 11, 1299-1300(Nov 1971).

Atmospheric air samples collected in the region of a copper smelting complex were analyzed. TBP, diluted with xylene, is used for the concentration and separation of Te from interfering elements. Te is reextracted from the organic phase with 0.1N HCl, and determined by a photometric method using Butylrhodamine S. Accuracy of the results was verified on standard solutions of Te and mixtures containing Fe, Zn, Pb, Bi, Sb, Se, and Cr in equal amounts with Te and twice the amount of Cu. (J.G.B.)

40601 AUTOMATIC DEVICE FOR THE DETERMINATION OF THE SUM OF METALS IN URANIUM-PLUTONIUM CARBIDES AND THE OXYGEN METAL RATIO IN URANIUM-PLUTONIUM MIXED OXIDES. Bartscher, W. (Europaeisches Institut fuer Transurane, Karlsruhe, Ger.). Z. Anal. Chem.; 258: No. 5, 346-8(1972). (In German).

An apparatus for the semiautomatic gravimetric determination of the sum of uranium and plutonium in carbides as well as the oxygen/metal ratio in uranium-plutonium mixed oxides is described. The principle underlying the determination of total metals is removal of carbon by heating in an air stream and reduction of the oxides to dioxides in a CO/CO_2 atmosphere. For the determination of the oxygen/metal ratio only the latter part of this method is used. The time needed for twelve determinations carried out simultaneously is two man-hours. (auth)

40602 OSCILLOMETRIC TITRATION OF INORGANIC HALIDES WITH MERCURY(II) ACETATE. Fischer, A.; Posgay, E. (State Inst. for Pharmacy, Budapest). Z. Anal. Chem.; 258: No. 5, 356-8(1972).

The difference between the relative ion mobility of the acetate and halide ions, and the well-known slight dissociation of the mercury halides can be used for the titrimetric determination of the inorganic chlorides, bromides, and iodides with oscillometric determination of the end-point. Errors in the determination of various halogenides were between 0.2 and 1.4%. (auth)

40603 ANALYSIS OF HYDROGEN-DEUTERIUM MIXTURES. Low, George M. U. S. Patent 3,666,942. 30 May 1972. Filed 6 Nov 1970.

A hydrogen-deuterium mixture is partially separated by helium carrier gas chromatography to form an effluent that is measured to determine total hydrogen isotopic concentration. The HD component of the effluent is ionized to form HD^+ ions. The HD^+ 1-0 band absorption is then measured with a conventional high resolution infrared detector providing a signal indicative of absolute deuterium concentration (as HD). The H/D ratio is readily determined from the total concentration and deuterium concentration. (Official Gazette)

40604 DETERMINATION OF TRACE METALS IN MICROLITRE SAMPLES BY PLASMA TORCH EXCITATION WITH SPECIAL REFERENCE TO OIL, ORGANIC COMPOUNDS, AND BLOOD SAMPLES. Greenfield, S.; Smith, P. B. (Albright and Wilson, Ltd., Oldbury, Eng.). Anal. Chim. Acta; 59: No. 3, 341-8(May 1972).

A method is described for multi-element analysis in which microliter samples of solutions of inorganic and organic materials are used. Samples are introduced into the high-frequency plasma torch by means of a small heated nebulizer, and the emission is recorded by conventional spectrographic techniques. Detection limits for various metals are in the range 10^{-9} to 10^{-10} g; at the 10^{-9} level, precision is of the order of 5%. Examples of the application of the method to the determination of trace elements in oil, organic compounds, and blood are given. Limits of detection are given for several elements, including La. (auth)

40605 BEHAVIOR OF ALKALI METALS IN THE HYDROGEN FLAME IONIZATION DETECTOR FOR ULTRA-MICRO ANALYSIS OF ALKALI AND ALKALINE EARTH METALS. Yamada, Masaaki; Suzuki, Shigetaka; Araki, Shun (Tokyo Metropolitan Univ.). Bull. Chem. Soc. Jap.; 45: No. 4, 1093-7(Apr 1972).

The behavior of alkali metals in the small hydrogen flame for ultramicro analysis of alkali and alkaline earth metals was investigated. The distribution of free neutral atoms and the formation of alkali hydroxides were studied by the photometric method, the distribution of charged particles was determined by the Langmuir probe method, and confirmation of whether negatively charged particles are mostly electrons or negative ions by the sheath method. It was found that only lithium formed a hydroxide in the flame, ionization chiefly occurred in the part 0 to 5 mm above the jet, and that most of negatively charged particles are not electrons but negative ions. (auth)

40606 CONTINUOUS DETERMINATION OF IODINE CONCENTRATION IN GASEOUS MIXTURE. Bartovsky, T.; Bartovska, L.; Cerny, C. (Vysoka Skola Chemicko-Technologicka, Prague). Chem. Listy; 66: No. 5, 541-5(May 1972). (In Czech).

A continuous method of determination of low concentrations of iodine in gaseous mixtures is described, based on the extraction of iodine with benzene and subsequent photometry of the benzene phase. The method was tested by the measurement of iodine vapor tension (0 to 20°C) and results agreeing with literature data were achieved. (auth)

40607 STARCH-CERIUM(IV) COMPLEXES IN AQUEOUS MEDIA: FORMATION, ISOLATION, AND STABILITY. Gugliemelli, L. A.; Doane, W. M.; Russell, C. R.; Swanson, C. L. (Dept. of Agriculture, Peoria, Ill.). J. Polym. Sci., Part B; 10: No. 6, 415-21(Jun 1972).

A method was developed for isolation and analysis of the complexes and the effect of reaction conditions on the extent of complexing was determined. The complexes are precipitated from aqueous solutions with absolute ethanol and the cerium(IV) content of the precipitate is determined. The validity of the gravimetric method for determining bonded cerium(IV) is shown. (M.C.G.)

Radiometric and Radiochemical Procedures

Refer also to abstracts 40942, 40943, 40987, 41475, and 41477.

40608 RADIOMETRIC FINISH FOR THE MICRODETERMINATION OF SOME MONOVALENT CATIONS. Mehra, M. C.; O'Brien, P. (Univ. of Moncton, N. B.). Radiochem. Radioanal. Lett.; 10: No. 4, 209-15(10 Jun 1972).

An indirect radiometric method for the determination of some monovalent cations is proposed. The cations K^+, Rb^+, Cs^+, Tl^+, and Ag^+ in slightly acidic medium are precipitated as their tetraphenylborates and the reagent in excess over the cation concentration is determined radiometrically with standard radioactive silver nitrate. The limit of detection for alkali cations is 15 μg/ml, while the heavier Tl^+ and Ag^+ cations can be detected up to 40 μg/ml. Alkaline earth cations up to 400 μg/ml do not interfere. (auth)

40609 PROTON- AND ELECTRON-EXCITED AUGER ELECTRON SPECTRA OF MOLYBDENUM SURFACES. Musket, R. G.; Bauer, W. (Sandia Labs., Livermore, Calif.). Appl. Phys. Lett.; 20: No. 11, 455-6(1 Jun 1972).

Proton- and electron-excited Auger electron spectra of molybdenum surfaces were measured. From the conditions of the experiments, the yields (i.e., Auger electrons/incident particle) for the two cases were comparable. The value of proton-excited Auger electron spectra is discussed with regard to quantitative surface-composition determinations. (auth)

40610 DETERMINATION OF A QUANTITY OF BERYLLIUM AND URANIUM ON SYNPOR: MICROFILTERS. Vespalec, Rudolf; Marik, Petr; Hogel, Josef; Franc, Ladislav. (Skoda Works, Plzen, Czech.). Jad. Energ.; 18: No. 6, 181-2(Jun 1972). (In Czech).

Methods and apparatus for the determination of quantity of beryllium and uranium produced by a nuclear fuel during life tests in a nonactive gas loop are described. The SYNPOR microfilters are set in the by-passes of the gas loop. The content of beryllium on the filters is measured by means of a photoneutron method with an isotope ^{124}Sb as a gamma source. The amount of uranium is determined by counting the alpha activity of a filter. The calibration is carried out with help of a set of etalon filters with a predetermined content of beryllium and uranium. (auth)

40611 SECOND INTERNATIONAL CONFERENCE ON X RAY ANALYTICAL METHODS, TOULOUSE, FRANCE, SEPTEMBER 6, 1971. Issy-les-Moulineaux, France; Compagnie Generale de Radiologie (1971). 172p. (In French). (CONF-710937).

Thirty-seven papers were presented at this conference on x-ray analytical methods. Four of them are abstracted separately for NSA. (France)

For abstracts of individual papers see: 40612, 40613, 40942, and 40987.

40612 TECHNOLOGICAL CHANGES AND THE FUTURE ENVISAGED FOR X-RAY SPECTROMETRY. Grubis, B. (Compagnie Generale de Radiologie, Paris). pp 75-7 of Second International Conference on X Ray Analytical Methods. Issy-les-Moulineaux, France; Compagnie Generale de Radiologie (1971). (In French).

From International conference on x ray analytical methods; Toulouse, France (6 Sep 1971). See CONF-710937.

The methods used in x-ray spectrometry to obtain an improvement in sensitivity (sealed tubes with narrow windows, tubes without windows, hot-cathode tubes, and cold-cathode tubes), detection (collimators, crystals, gas-flow counters, and signal-processing equipment), and reliability (reduction of instrument drift) are presented. Problems concerning the presentation of the samples and the analysis of volatile liquids are discussed. (France)

40613 USE OF A MODULATED X-RAY FLUX IN ANALYSIS: APPLICATION TO URANIUM DETERMINATION IN THE PRESENCE OF HIGH ACTIVITY. Baudin, G.; Nens, B.; Sarrat, P. (CEN, Fontenay-aux-Roses, France). pp 99-102 of Second International Conference on X Ray Analytical Methods. Issy-les-Moulineaux, France; Compagnie Generale de Radiologie (1971). (In French).

From International conference on x ray analytical methods; Toulouse, France (6 Sep 1971). See CONF-710937.

Nitric acid solutions were used to determine U. In order to reduce the level of radioactivity, small volumes of the solution deposited on disks of absorbant paper were used. A semi-automatic deposition device was developed, a good reproducibility being obtained for the volumes deposited (better than 1%). A modulated x-ray flux was used. The detection limit is 0.25g/1 of U and the relative error is similar to that involved in the methods generally used. (France)

40614 RADIOISOTOPIC X-RAY ANALYSIS. PART I. AN INSTRUMENTAL CONFIGURATION FOR THE SENSITIVE DETERMINATION OF A NUMBER OF ELEMENTS. De Neef, J.; Adams, F.; Hoste, J. (Univ., Ghent). Anal. Chim. Acta; 59: No. 3, 333-40(May 1972).

The use of a 90° symmetry arrangement for the determination of elements from $Z = 30$ to 78 by means of an energy-dispersive x-ray fluorescence spectrometer with isotopic excitation sources is described. ^{241}Am and ^{170}Tm were evaluated as the excitation sources. (auth)

40615 CONTINUOUS AUTOMATIC INSTRUMENTATION FOR PROCESS APPLICATIONS. Lewis, C. D. (E. I. du Pont de Nemours and Co., Wilmington, Delaware). pp 6293-6404 of Treatise on Analytical Chemistry. Part I. Theory and Practice. Volume 10. /Kolthoff, I. M. (ed.). New York; John Wiley and Sons, Inc. (1972).

The following topics are presented: an introduction, including historical, calibration, and general considerations; the sample, including collection, treatment, and metering the sample, and sequencing discontinuous samples; separation and treatment of the desired constituent, including conditions for reproducibility and attainment of selectivity; methods of measurement, including electrical, radiant energy, thermal, magnetic, and other methods; presentation and calculation of data, including analog and digital representation, data assimilation and reduction, types of computers, and final outputs; and literature sources. (267 references). (J.G.B.)

40616 TRACE ELEMENT NUTRITURE AND METABOLISM THROUGH HEAD HAIR ANALYSIS. Strain, William H.; Pories, Walter J.; Flynn, Arthur; Hill, Orville A. Jr. (Cleveland Metropolitan General Hospital). pp 383-97 of Trace Substances in Environmental Health. V. /Hemphill, Delbert D. (ed.). Columbia, Mo.; Univ. of Missouri (1971).

From fifth annual conference on trace substances in environmental health; Columbia, MO. (29 Jun 1971). See CONF-710645.

Knowledge of trace element nutriture and metabolsim can be greatly advanced through analyses of head hair from man, and body hair from animals. Determination of element content of hair is being used extensively for the detection of toxic levels of metals, for measuring deficiencies of essential elements, and for criminological identification in forensic medicine. Hair metabolism may be measured by uptake and retention of radioisotopes. Measurements on plucked and clipped hair, collected simultaneously from rats at various time intervals after intravenous injection, show marked differences in patterns of accumulation for the various radionuclides. Some radioisotopes show a slight surge into and out of hair immediately after administration, even though hair is a devitalized tissue with a low metabolic turnover. These measurements with radionuclides offer great possibilities for correlating hair elements with other body pools. Determination of hair radioactivity also has potential as a method of diagnosing inadvertent exposure to radioisotopes or radiation which produces radioisotopes in the body. Although there has been considerable inadvertent malversation of hair analyses in the past, standardization of techniques will correct this. Hair analysis offers so much promise as an epidemiological tool, that carefully collected hair samples from a barber shop probably can be used to monitor exposure to toxic concentrations of arsenic, cadmium, lead, and mercury, or to deficiencies of essential elements. (auth)

40617 TRACE ELEMENT ANALYSIS BY CHARGED PARTICLE INDUCED CHARACTERISTIC X RAYS. Gordon, B. M.; Kraner, H. W. (Brookhaven National Lab., Upton, N. Y.). pp 419-33 of Trace Substances in Environmental Health. V. /Hemphill, Delbert D. (ed.). Columbia, Mo.; Univ. of Missouri (1972).

From fifth annual conference on trace substances in environmental health; Columbia, MO. (29 Jun 1971). See CONF-710645.

The development in recent years of high resolution semiconductor detectors has made possible the simultaneous analysis of trace elements in picogram amounts through detection of characteristic x rays induced by energetic charged particle projectiles. Charged particles, such as protons, alpha particles, and heavy ions, in the 3- to 200-MeV energy range lose energy by ionization of electrons from target atoms. The x rays characteristic of the target atoms are detected with a resolution sufficient to separate the Kα lines of neighboring elements for $Z > 12$. Thus, simultaneous analysis is possible within limits that depend on relative concentrations present. Analysis of samples containing 10^{-12} grams or less is possible. The results of theoretical calculations for x ray yields from a variety of projectiles of varying energies will be presented. Brookhaven National Laboratory has facilities for accelerating protons up to 200 MeV, alpha particles up to 50 MeV, and heavy ions, such as bromine, up to 80 MeV; the possible adaptation and application of these facilities to trace element analysis is being considered. The experimental results of work at Brookhaven and elsewhere will be reviewed. Targeting problems will also be considered. (auth)

40618 DETERMINATION OF THE SPECIFIC ACTIVITY OF γ-EMITTING ISOTOPES IN EXTENDED SOURCES WITHOUT SAMPLE COLLECTION. Polyakov, V. I.; Chechetkin, Yu. V. This paper was summarized in At. Energ. (USSR); 31: No. 2, 139 (Aug 1971) as paper No. 519/6079. (In Russian).

Full copy of this paper is held by TIC.

Approximate analytical expressions for calculating the relative photoefficiency of the recording by a scintillation γ-spectrometer with a collimator in the determination of the specific activity of isotopes in sources with simple configurations (point, line, plane, plate) of volume and surface cylindrical sources are considered. For an experimental verification of the possibility of using the expressions, volume cylindrical sources filled with an aqueous solution of a radioactive isotope and surface cylindrical sources with self-absorption in water and without it were used. Crystals of NaI(Tl) with dimensions 70 × 70 and 40 × 40 mm, and collimators 150 and 250 mm long, 5, 10, 20, and 50 mm in diameter were used. For the entire range of γ-quantum energies considered (0.1 to 1.5 MeV), distances (25 to 170 cm), dimensions of sources (diameter 16 to 255 mm), and collimators, the deviation of the experimental points from the calculated values of the relative photoefficiency of recording lies within the limits of the experimental errors and comprises 10 to 15%. The value of the minimum measurable specific activity of the isotopes is 10^{-7} Ci/liter for volume cylindrical sources and 10^{-9} Ci/cm^2 for surface cylindrical sources. The method of measurement was used to determine the activity of a coolant and to analyze deviations in the circuit of an atomic electric power plant. (W.H.K.)

40619 POTENTIAL ERRORS IN LIQUID SCINTILLATION COUNTING OF VERY DILUTE SOLUTIONS OF LABELED TETRACYCLINES. Allison, J. M.; Monro, A. M.; Offerman, J. L. (Pfizer Ltd., Kent, Eng.). Anal. Biochem.; 47: No. 1, 73-9(May 1972).

Determination of the specific activity of low concentrations of tritiated doxycycline (indexed as 4-(dimethylamino)-1,4,4a,5,5a,6,11,12a-octahydro-3,5,10,12,12a-pentahydroxy-6-methyl-1,11-dioxo-2-naphthacenecarboxamide) or tritiated tetracycline by liquid scintillation counting in a toluene scintillator in glass vials gave misleadingly low values through adsorption to the wall of the vial. The phenomenon was more pronounced in nylon and polyethylene vials. Use of Cab-O-Sil or of siliconized glass vials gave better, but still unsatisfactory, results. The problem can be overcome by addition of unlabeled solute to bring the concentration of the solution being counted to above 5 μg/ml. Results obtained for doxycycline with Triton X-100 scintillator in glass or polyethylene vials were reliable, with little variation over a wide range of concentration, but nylon vials again proved to be unsatisfactory. (auth)

40620 DETERMINATION OF TRACE AMOUNTS OF URANIUM IN SILICATE MINERALS BY THE FISSION TRACK TECHNIQUE. Matsuda, Hideki; Tsutsui, Yutaka; Nakano, Shigenori; Umemoto, Shunji (Kyushu Univ., Fukuoka). Talanta; 19: No. 7, 851-6 (Jul 1972).

The fission track technique was applied to the determination of uranium on Dowex 1 × 8 after chemical separation from silicates. Standard rock and several stone meteorite samples were treated by this method and satisfactory results were obtained. The procedure is applicable to natural waters. (auth)

Separation Procedures

40621 (JINR–P6-6401) RARE EARTH AND TRANSURANIUM ELEMENT SEPARATION BY PARTITION CHROMATOGRAPHY WITH TETRABUTYLHYPOPHOSPHORIC ACID. Korotkin, Yu. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 7p. (In Russian). Dep. NTIS (U. S. Sales Only).

On a column of cellulose, impregnated with a 0.5M solution of tetrabutylhypophosphoric acid, separation of the rare earth and transuranium elements is performed as well as of Sc, Hf, Zr, Nb, and Ag. HNO_3 and $HClO_4$ were used as eluents. (auth)

40622 (JINR–P6-6477) GAS-ADSORPTION CHROMATOGRAPHY OF CHLORIDE COMPLEXES OF LANTHANIDE ELEMENTS WITH ALUMINUM CHLORIDE. Zvarova, T. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 7p. (In Russian). Dep. NTIS (U. S. Sales Only).

The total resolution of the neighboring element peaks was obtained for the whole series of lanthanides by chromatography of the chloride complexes of the lanthanide elements with aluminum chloride on a column with glass ball packing. (auth)

40623 (KFK–1504) REACTION OF 4-ACYL-SUBSTITUTED 3-METHYL-1-PHENYL-2-PYRAZOLIN-5-ONE WITH ACTINIDE IONS IN AQUEOUS SOLUTIONS. Bacher, Walter (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Dec 1971. 108p. (In German). Dep. NTIS (U. S. Sales Only).

Various actinide ions M^{n+} (Ac^{3+}, Th^{4+}, UO_2^{2+}, Am^{3+}, Cm^{3+}, Cf^{3+}) are extracted from aqueous solution as their chelates with 1-phenyl-3-methyl-4-acylpyrazolin-5-one (acyl = benzoyl, acetyl, chloroacetyl, trichloroacetyl, trifluoroacetyl). The $pH_{1/2}$ values for the extractions were determined as well as the stability constants β_n and the extraction constants K_{ex} of the metal chelates. Mostly the 1 : n chelates ML_n of the ions M^{n+} were extracted. The only exception was the basic chelate $Am(OH)(PMCP)_2$ with 1-phenyl-3-methyl-4-chloroacetylpyrazolin-5-one (HPMCP). Synergistic effects were observed when some organic compounds containing C=O-, P=O-, or P=S-groups were added to the extraction system Am^{3+}/1-phenyl-3-methyl-4-benzoylpyrazolin-5-one (HPMBP)/$CHCl_3$. Generally, the 1 : 1 and 1 : 2 adduct chelates were obtained, and with trioctylphosphine sulfide (TOPS) also a 1 : 3 adduct chelate was formed. The corresponding adduct stability constants could be determined by a graphical method. Using tributylphosphine oxide (TBPO), trioctylphosphine oxide (TOPO), and triphenylphosphine oxide (TPPO) an antagonistic effect could be observed. Spectrophotometric titration of pentavalent neptunium with 1-phenyl-3-methyl-4-acetylpyrazolin-5-one (HPMAP) showed the formation of 1 : 1 and 1 : 2 chelates. Their stability constants can be determined using a computer program. No complex formation can be determined between trivalent americium and HPMAP using spectrophotometric and ion exchange methods. The reasons for this behavior are discussed. (auth)

40624 INORGANIC CATION EXCHANGERS HAVING A SIEVE EFFECT AND THEIR USE FOR SEPARATION OF ALKALI METALS. Leont'eva, G. V.; Vol'khin, V. V. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 12, 2700-4(Dec 1971).

Translated from Zh. Prikl. Khim.; 44: No. 12, 2615-20(Dec 1971).

A study of the sorption properties of the newly synthesized ion-sieve cation exchangers ISM-1 and ISM-2 showed that the first of these can be used for selective extraction of Li^+ ions from solutions with high concentrations of alkali and alkaline earth salts and the second for removal of lighter alkali metals from rubidium and cesium salts. (auth)

40625 SORPTION OF ZIRCONIUM BY KU-1 RESIN FROM HYDROCHLORIC ACID SOLUTIONS. Zhukov, A. I.; Mansurov, A. P.; Sintserov, V. S. (Ural Polytechnic Inst., Sverdlovsk, USSR). J. Appl. Chem. USSR (Engl. Transl.); 44: No. 12, 2705-10(Dec 1971).

Translated from Zh. Prikl. Khim.; 44: No. 12, 2621-7(Dec 1971).

The influence of the free hydrochloric acid concentration in solution (C_{HCl}) on sorption of zirconium from 0.05M solutions of its dichloride by KU-1 resin was studied. At C_{HCl} in the region of 2.4M zirconium was sorbed in the form of Zr^{4+} ions, and at lower C_{HCl} in the form of multinuclear hydroxo complexes. The average hydroxyl number of zirconium ions in the resin at C_{HCl} = 0.30M is 2.8. Washing of the resin with 1N ammonium chloride solution raises it to 3.15, regardless of C_{HCl} during sorption. The results are discussed in the light of concepts of continuous hydrolysis of zirconium in the resin at C_{HCl} 0.9M, and formation of $Zr[(OH)_3Zr]_n^{(4+n)+}$ and $Zr[(OH)_4Zr]_{h_1}$. Precipitation of basic zirconium salts from solutions is regarded as the consequence of formation of $Zr[(OH)_4Zr]_{n_1}^{4+}$ ions and of the low solubilities of the salts corresponding to these ions at high n_1. (auth)

40626 SOLVENT EXTRACTION OF LANTHANIDES FROM MOLTEN ALKALINE NITRATES. Foos, J.; Guillaumont, R. (Paris Univ., Orsay, France). Radiochem. Radioanal. Lett.; 10: No. 4, 201-8(10 Jun 1972). (In French).

Solvent extraction of lanthanides (~10^{-6}M) at 150°C from a molten $LiNO_3-KNO_3$(1 : 2) mixture by TBP or TPPO (triphenylphosphine oxide) in a polyphenyl mixture was studied. Plots of the log distribution coefficients of these elements vs log free TBP or TPPO concentration in the organic phase are reported, except for Ce and Tb which are not extracted and for Ho, Er, and Tm whose behavior in this system is different from the others. (auth)

40627 ION EXCHANGE SEPARATION OF ^{242}Cm FROM PLUTONIUM, AMERICIUM, AND FISSION PRODUCTS. Thompson, G. H. (Savannah River Lab., Aiken, S. C.). Contract AT(07-2)-1. Radiochem. Radioanal. Lett.; 10: No. 4, 223-30 (10 Jun 1972).

Curium-242 was separated from plutonium by anion exchange and from americium and fission products by pressurized cation exchange in a high-flow system. (auth)

40628 PROCESS FOR SEPARATING SOLUBLE IMPURITIES FROM URANIUM COMPOUNDS. Pirk, H.; Ploeger, F.; Vietzke, H. (to NUKEM-Nuklear-Chemie und Metallurgie). Canadian Patent 894,137. 29 Feb 1972. Priority date 22 Apr 1969, Germany.

Water-soluble impurities can be separated from a uranium compound by adding a precipitation agent (ammonium carbonate, ammonium acid carbonate, or a mixture of ammonia and carbon dioxide) to an aqueous solution of the compound and precipitating the uranium as ammonium uranyl carbonate. The pH for the precipitation process is 7.5 to 9. (Canada)

40629 EFFECT OF RESIN CROSS-LINKING ON THE ANION-EXCHANGE SEPARATION OF RARE EARTH COMPLEXES WITH DCTA. Wodkiewicz, Ludmila; Dybczynski, Rajmund (Inst. of Nuclear Research, Warsaw). J. Chromatogr.; 68: No. 1, 131-41 (31 May 1972).

The anion-exchange separation of rare earth–DCTA complexes in the system: Dowex I $[H_2Z^{2-}]-Na_2H_2Z$ was investigated on resins of 2, 4, 8, 10, and 16 nominal crosslinking, respectively. Selectivity coefficients, separation factors, and especially plate heights and resolutions were found to depend markedly on resin crosslinking. In this system longitudinal diffusion in the stationary phase was shown to contribute significantly to plate height as was the case in the anion-exchange separation of rare earth–EDTA complexes, also. The existence of a sieve effect towards complex ions in the case of highly crosslinked resins was ascertained. Direct comparison of the ion-exchange affinities of the lanthanide–EDTA and lanthanide–DCTA complexes in the system: Dowex I X4$[Cl^-]$–NaCl (aq.) seems to confirm the previously suggested hypothesis of gradual changes in the structure of complex ions with the variation of central atom radius. (auth)

40630 CHROMATOGRAPHY OF METAL IONS ON POLYAMIDE THIN LAYERS. Lederer, Michael; Rinalduzzi, Bruno (CNR, Rome). J. Chromatogr.; 68: No. 1, 237-44(31 May 1972).

The retention of a range of heavy metal ions including UO_2(II), on Polyamide II thin layers was examined. Aqueous HCl, ethanol-HCl, butanol–HCl, and acetone–HCl mixtures were used as solvents. (auth)

40631 SEPARATION OF MOLYBDENUM FROM SEVERAL INTERFERING ELEMENTS BY TRIBENZYLAMINE EXTRACTION OF ITS THIOCYANATE. Yatirajam, V.; Ram, Jaswant (Univ. of Kurukshetra, India). Anal. Chim. Acta; 59: No. 3, 381-7 (May 1972).

A simple extraction of molybdenum for routine analysis is proposed. Molybdenum(VI) is reduced with hydrazine sulphate in 2 M hydrochloric acid. Fluoride is added to mask various metal ions, and the Mo(V)–thiocyanate complex is extracted by 1% tribenzylamine in chloroform. Molybdenum is back-extracted with an alkaline hydrogen peroxide solution. After suitable treatment, milligram amounts of molybdenum are determined by titration with cerium(IV) solution, and microgram amounts by spectrophotometry of the thiocyanate complex. The separation requires only about 20 min (<10 min in series operation) and separates molybdenum from Ti, V, Cr, Mn, Fe, Co, Ni, Zr, Nb, W, Ce, Bi, U, Ru, Pb, and Sb. The wide applicability of the method is shown by satisfactory analysis of a variety of synthetic samples for molybdenum. (auth)

40632 SELECTIVE SEPARATION OF COPPER FROM OTHER ELEMENTS BY CATION-EXCHANGE CHROMATOGRAPHY IN HYDROCHLORIC ACID–ACETONE MEDIA. Strelow, F. W. E.; Victor, A. H. (National Chemical Research Lab., Pretoria). Anal. Chim. Acta; 59: No. 3, 389-96(May 1972).

Copper can be separated from Ga, Fe(III), Zn, Cd, Sn(IV), In, Tl(III), Te(IV), As(III), Se(IV), Mo(VI), W(VI), Au(III), Pd(II), Pt(IV), Rh(III), and Hg(II) by eluting these elements with 0.2 M hydrochloric acid–85% acetone from a column of AG50W-X8 resin, 200 to 400 mesh, while the copper is retained. Mo(VI) and W(VI) require the presence of hydrogen peroxide. Copper then can be eluted with 0.5 M hydrochloric acid–85% acetone. Only uranium (VI) is partially eluted together with copper. Elements such as Co, Ni, Mn, Li, Na, K, Rb, Cs, Be, Mg, Ca, Sr, Ba, Ti(IV), V(IV), Hf, Zr, Th, Al, Sc, Y, La and lanthanides are retained on the column. Separations are sharp and quantitative, as is demonstrated by results for some synthetic mixtures. Elution curves are presented for the separation of the most critical element pairs. (auth)

40633 SOLVENT EXTRACTION FROM MOLTEN EUTECTIC $LiNO_3$–KNO_3 OF SOME 5f ELEMENTS BY DIPHENYLDIPHOSPHINE DIOXIDES AND TRI-n-OCTYLPHOSPHINE OXIDE. Foos, Jacques; Mesplede, Jacques (Paris Univ., Orsay, France. Univ., Lyon). J. Inorg. Nucl. Chem.; 34: No. 6, 2051-6(Jun 1972).

The extraction of the "5 f" elements americium, curium and californium from a molten salt phase at 160°C ($LiNO_3-KNO_3$: mole ratio 3:4) with an organic solution in a eutectic of polyphenyls of some diphenyldiphosphine-dioxides: $(C_6H_5)_2PO(CH_2)_n PO(C_6H_5)_2$ = n-DPO n – 2, 3, 4, 6 and tri-n-octylphosphine oxide (TOPO) was investigated. The slopes of log–log plots for the distribution coefficients for these elements vs. the concentration of the extractant are one for 2-DPO and TOPO and two for 3-DPO and 4-DPO. Am, Cm, and Cf are not extracted with 6-DPO in such a system. (auth)

40634 ION-EXCHANGE STUDY OF EQUILIBRIUM BETWEEN DIFFERENT FORMS OF RUTHENIUM IN ACID SOLUTIONS. Sorokin, V. G.; Zhurin, A. I.; Alekseeva, M. E. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 11, 2664-5(Nov 1971).

Translated from Zh. Prikl. Khim.; 44: No. 11, 2584-5(Nov 1971).

Studies were made on the sorption of ruthenium from acid solutions by ion exchange resins under static and dynamic conditions. Ruthenium exists in three forms in acid solutions: cationic, neutral, and anionic. These forms exist in dynamic equilibrium. (M.C.G.)

40635 APPLICATION OF THERMODYNAMIC MEASUREMENTS OF POLYELECTROLYTE SOLUTIONS FOR THE PREDICTION OF ION-EXCHANGE SELECTIVITY. Reddy, M. M.; Amdur, S.; Marinsky, J. A. (State Univ. of New York, Buffalo). J. Amer. Chem. Soc.; 94: No. 12, 4087-93(14 Jun 1972).

A thermodynamic calculation of the modified selectivity coefficient, K_{AC}, was made employing the Gibbs–Donnan equation for the exchange of several trace divalent ions and trace sodium ion with macro divalent ion in crosslinked polystyrenesulfonate ion exchange resins. Evaluation of activity coefficient ratios of the exchanging ions in the resin phase was accomplished using the Gibbs–Duhem equation and osmotic coefficients of polystyrenesulfonates. The osmotic free energy of the exchange reaction was estimated using polystyrenesulfonate osmotic coefficients and ionic partial molal volumes. Calculated modified selectivity coefficients for divalent–divalent ion exchange in general agree with experimentally determined values. Significant discrepancies were found between calculated and experimental selectivities for trace sodium–divalent ion exchange at high resin-phase concentrations. The theoretical treatment of polyelectrolytes by Manning has been used to explain this result. (auth)

40636 INVESTIGATION OF DESORPTION PROCESSES OF URANYL ION WITH THE CARBONATE FORMS OF AV-17, AV-16, AND EDE-10 ANION EXCHANGERS. Eristavi, V. D.; Kutsiava, N. A. Soobshch. Akad. Nauk Gruz. SSR; 66: No. 3, 589-92(Jun 1972). (In Georgian).

Optimal conditions of elution were determined on the basis of a study of the effect of various factors on the desorption of uranyl ions from the carbonate forms of AV-17, AV-16, and EDE-10 anion exchangers. Possible schemes of separating uranyl ions from elements hindering its determination are proposed. (auth)

40637 SEPARATION OF COBALT AND NICKEL FROM ACCOMPANYING ELEMENTS BY USING THE FLUORIDE- AND EDTA-FORMS OF ANION EXCHANGERS. Brouchek, F. I.; Gotsiridze, Sh. P.; Kochiashvili, E. A. (Tbilisi Polytechnical Inst., USSR). Soobshch. Akad. Nauk Gruz. SSR; 66: No. 3, 593-6(Jun 1972). (In Russian).

The sorption behavior of the following elements was studied comparatively under dynamic conditions: cobalt, nickel, titanium(IV), beryllium, copper, silver, tungsten(VI), and chromium(III) on the fluoride form of the AV-16 anion exchanger and cobalt, nickel, manganese(II), iron(IV), chromium(III), copper, titanium(IV), molybdenum(V and VI) and uranium(VI) on the EDTA form of the AV-17 anion exchanger. Chromatographic methods were developed for separating cobalt and nickel from the above-mentioned accompanying elements. (auth)

40638 EXTRACTION CAPACITY OF SULFOXIDES. IV. INFLUENCE OF THE LENGTH OF THE CHAIN. Rozen, A. M.; Murinov, Yu. I.; Nikitin, Yu. E.; Krivonogov, V. P. Sov. Radiochem. (Engl. Transl.); 13: No. 6, 917-18(1971).

Translated from Radiokhimiya; 13: No. 6, 891-3(1971).

A comparative study of the extraction capacity of cyclic sulfoxides with the same molecular weight showed that in the extraction of uranyl nitrate the six-membered cyclic sulfoxide ($\overline{K}$ = 7500) is more effective than the five-membered cyclic sulfoxide ($\overline{K}$ = 4000). Both sulfoxides form disolvates with uranyl nitrate. The compounds studied are the 1-oxides of 2-butyltetrahydro-5-methylthiophene and 2-butyltetrahydrothiopyran. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstract 40998.

Chemical and Physico-chemical Properties

Refer also to abstracts 41329 and 41682.

40639 IMPROVED METHOD FOR THE PREPARATION OF SULFUR DIOXIDE FROM BARIUM SULFATE FOR ISOTOPE RATIO STUDIES. Bailey, S. A.; Smith, J. W. (CSIRO, North Ryde, Australia). Anal. Chem.; 44: No. 8, 1542-3(Jul 1972).

In order to control the pressure of the oxygen released during the decomposition of $BaSO_4$, a modification consisting of a removable silica tube packed with metallic copper turnings heated to 800°C was made to the apparatus used by Holt and Engelkemeir (Anal. Chem. 42, 1451(1970)). This modification reduced to a minimum the sulfur trioxide content in the gaseous products resulting in sulfur dioxide yields of 96% of theoretical. (D.H.M.)

Isotope Effects

Refer also to abstract 42452.

40640 DEUTERIUM ISOTOPE EFFECTS IN CYCLISATION OF MONOTERPENOIDS. Bunton, C. A.; Leresche, J. P.; Hachey, D. (Univ. of California, Santa Barbara). Tetrahedron Lett.; No. 24, 2431-4(Jun 1972).

Kinetic deuterium isotope effects were determined for the hydrolysis of geranyl and neryl chlorides with various D substituent positions and results are discussed. The products were similar to those found for phosphate ester solvolysis, and consisted mainly of open chain olefins, cyclic olefins, linalol, nerol, geraniol and α-terpineol, but changed markedly when $LiClO_4$ was added; geranyl chloride gave large amounts of cyclic products in the latter case. (UK)

40641 ACCESSORIES TO THE TEN-METER CZERNY-TURNER SPECTROGRAPH AND SPECTRAL RESOLUTION ACHIEVED IN THE NEAR INFRARED: STUDY OF BANDS OF ^{18}O ENRICHED CARBON DIOXIDE. Vigil, Jerome Allen. Columbus, Ohio; Ohio State Univ. (1971). 357p. University Microfilms Order No. 72-15,315.

Thesis.

The development of the ten-meter Czerny–Turner-type vacuum infrared spectrograph that is equipped with two of the largest and most recently ruled precision gratings is reported. The performance of the instrument has been demonstrated to be highly satisfactory as indicated by the spectral resolution achieved and the spectral line positions determined. The infrared spectra of the ^{18}O-enriched species of the carbon dioxide molecule were investigated. For the first time, the low frequency bands of this isotopic variety of carbon dioxide were recorded, measured, and interpreted; a Littrow-type vacuum infrared spectrograph equipped with a liquid-helium-cooled Ge : Cu detector was used for these experiments. In addition, the near infrared bands of this molecule were re-examined with the improved resolution of the ten-meter Czerny–Turner instrument. New or refined molecular constants were determined from the observational data for several isotopic varieties of carbon dioxide in addition to the ^{18}O variety. All these other isotopic species occurred as impurities in the sample used. (Diss. Abstr. Int., B)

40642 SECONDARY KINETIC ISOTOPE EFFECTS IN BIMOLECULAR NUCLEOPHILIC SUBSTITUTIONS. V. THE ROLE OF THE SOLVENT IN THE REACTION BETWEEN METHYL IODIDE AND PYRIDINE. Leffek, K. T.; ; Matheson, A. F. (Dalhousie Univ., Halifax, Nova Scotia). Can. J. Chem.; 50: No. 7, 982-5(1 Apr 1972).

Secondary kinetic deuterium isotope effects are presented for the reaction of methyl-d_3 iodide and pyridine in four different solvents. Calculations on mass and moment of inertia change with deuteration in the initial state and an assumed tetrahedral transition state, together with internal rotational effects, are used to rationalize the inverse isotope effects. It is concluded from the variation of the isotopic rate ratio that the transition state structure varies with solvent. (auth)

40643 SECONDARY KINETIC ISOTOPE EFFECTS IN BIMOLECULAR NUCLEOPHILIC SUBSTITUTIONS. VI. EFFECT OF α AND β DEUTERATION OF ALKYL HALIDES IN THEIR MENSCHUTKIN REACTIONS WITH PYRIDINE IN NITROBENZENE. Leffek, K. T.; Matheson, A. F. (Dalhousie Univ., Halifax, Nova Scotia). Can. J. Chem.; 50: No. 7, 986-91(1 Apr 1972).

A survey of kinetic, secondary deuterium isotope effects, for α-, β-, and γ-deuterated alkyl halides reacting with pyridine in nitrobenzene solvent was made. α-Deuterium effects were measured for eight compounds, β-deuterium effects for four compounds, and one rate ratio for γ-deuteration is reported. The possible errors in the rate ratios for β-deuterated compounds, resulting from the elimination side reaction, were determined. The results are discussed in terms of transition state structure. (auth)

40644 VAPOR PRESSURES OF NATURAL NEON AND OF THE ISOTOPES ^{20}Ne AND ^{22}Ne FROM THE TRIPLE POINT TO THE NORMAL BOILING POINT. Furukawa, George T. (National Bureau of Standards, Washington, D. C.). Metrologia; 8: No. 1, 11-27(Jan 1972).

Apparatus design and procedures are described for the determination of the vapor pressures of naturally occurring neon (^{nat}Ne) and the pure isotopes ^{20}Ne and ^{22}Ne from their triple points (TP) to their normal boiling points (NBP). The data have been fitted to vapor pressure equations with root-mean-square deviations of ±2.5 to ±4.7 N/m^2 (±0.019 to ±0.035 mmHg). The TP pressures (P) and the TP and NBP temperatures (T) were found to be:

	TP		NBP
	P	T,K	T,K
^{nat}Ne	43332 ± 13 N/m^2 (325.02 ± 0.10 mmHg)	24.553 ± 0.001	27.096 ± 0.001
^{20}Ne	43326 ± 13 N/m^2 (324.97 ± 0.10 mmHg)	24.540 ± 0.001	27.084 ± 0.001
^{22}Ne	43654 ± 13 N/m^2 (327.43 ± 0.10 mmHg)	24.687 ± 0.001	27.211 ± 0.001

(The temperatures are in terms of the NBS-1955 provisional temperature scale. The figures after the ± symbol indicate estimated uncertainties). The calculated vapor pressures of the isotopic ^{nat}Ne, based on Raoult's law of solution and the observed vapor pressures of the pure isotopes, are in agreement within the combined precision of the measurements with the observed values of ^{nat}Ne. (auth)

40645 INFRARED STUDIES OF ISOTOPE EFFECTS FOR HYDROGEN ADSORPTION ON ZINC OXIDE. Kokes, R. J.; Dent, A. L.; Chang, C. C.; Dixon, L. T. (Johns Hopkins Univ., Baltimore). J. Amer. Chem. Soc.; 94: No. 13, 4429-36(28 Jun 1972).

Kinetic and equilibrium isotope effects were studied for type I hydrogen, deuterium, and hydrogen deuteride adsorption on zinc oxide. At room temperature, there was no equilibrium isotope effect for hydrogen vs. deuterium, but the preferred form of adsorption of hydrogen deuteride appeared to be ZnH–OD rather than ZnD–OH by a factor of 2 to 3. Kinetic isotope measurements revealed that hydrogen adsorbs faster than deuterium by a factor of at least 5 at –195°C. The kinetic isotope effect for H at –195°C reveals ZnD–OH is the favored form by a factor of 20 to 100. Approximate computations of these effects based on observed ir frequencies reveal that these effects are explicable provided it is assumed that the bending vibrations for adsorbed species are either very low frequency compared to those observed for simple molecules or that the adsorption is mobile at room temperature. (auth)

40646 DIMERIZATION OF 1,2-CYCLOHEXADIENE, A MODEL FOR NONCONCERTED ALLENE DIMERIZATION. DETERMINATION OF A SECONDARY DEUTERIUM KINETIC ISOTOPE EFFECT BY DEUTERIUM NUCLEAR MAGNETIC RESONANCE. Moore, William R.; Mogolesko, Paul D.; Traficante, Daniel D. (Massachusetts Inst. of Tech., Cambridge). J. Amer. Chem. Soc.; 94: No. 13, 4753-4(28 Jun 1972).

Because of the mechanistic importance of the case of allene dimerization, it was decided to obtain experimental evidence establishing the nature of the intramolecular isotope effect in the product-forming step of a related reaction where independent evidence indicates that an intermediate is involved. The isotope effect was found to be 1.04 for dimerization of 1,2-cyclohexadiene compared to 1.06 found for allene. This provided support for Dolbier and Dai's interpretation of their kinetic isotope effects. (M.C.G.)

40647 E.S.R. STUDY OF SOME H–D SOLVENT ISOTOPE EFFECTS ON COPPER IONS. Znamirovschi, V.; Cozar, O.; Nicula, A. (Univ., Cluj). Isotopenpraxis; 8: No. 1, 29-32(Jan 1972).

An ESR study was made on copper ions in water and ammoniacal solutions in order to determine the H–D isotope effect that appears in the shape and the width modifications of spectral lines. The isotope effect is different in terms of the paramagnetic ion concentration at room and liquid nitrogen temperatures. These effects were explained by the isotopic modifications of dipolar interactions among copper ions and between copper ions and ligand nuclei and also by the isotopic modifications of crystalline field in frozen solutions. (auth)

40648 ALLENE–PERFLUOROCYCLOBUTANONE ENE REACTION. KINETIC ISOTOPE EFFECTS. Dia, Sheng-hong;

Dolbier, William R. Jr. (Univ. of Florida, Gainesville). J. Amer. Chem. Soc.; 94: No. 11, 3953-4(31 May 1972).

Primary and secondary deuterium isotope effects were utilized to elucidate the mechanism of the reaction between allene and perfluorocyclobutanone. The data obtained from intramolecular studies using 1,1- and 1,3-dideuterioallene and from an intermolecular study using tetradeuterioallene are most simply rationalized in terms of a concerted mechanism. (auth)

40649 DEUTERIUM ISOTOPE EFFECTS IN QUENCHING OF AROMATIC HYDROCARBON FLUORESCENCE BY CONJUGATED DIENES. Taylor, Gary N.; Hammond, George S. (California Inst. of Tech., Pasadena). J. Amer. Chem. Soc.; 94: No. 11, 3687-92(31 May 1972).

The mechanism of quenching of the fluorescence of anthracene and naphthalene by piperylene was investigated by looking for deuterium isotope effects. Perdeuteration of either the quencher or the quenchee results in small increases in the quenching constants and the effect is cumulative when both reactants contain deuterium. The results indicate that transfer of electronic excitation energy into C–H vibrations is not important in the rate-controlling step in quenching. Other vibrational motions may become dominant in the internal conversion process. There are several ways in which the small, inverse isotope effects measured can be rationalized as arising from effects on the equilibrium constants for formation of exciplexes, which may be intermediates in the decay process. (auth)

40650 SECONDARY DEUTERIUM ISOTOPE EFFECTS IN ALLENE CYCLOADDITIONS. Dai, Sheng-hong; Dolbier, William R. Jr. (Univ. of Florida, Gainesville). J. Amer. Chem. Soc.; 94: No. 11, 3946-52(31 May 1972).

Intramolecular kinetic secondary deuterium isotope effects were obtained for the reactions of allene-1,1-d_2 with acrylonitrile, 1,1-dichloro-2,2-difluoroethylene, tetracyanoethylene oxide, hexachlorocyclopentadiene, and 5,5-dimethoxytetrachlorocyclopentadiene and for the dimerizations of allene-1,1-d_2 and 1,2-cyclononadiene-1-d. Intermolecular effects were obtained for the acrylonitrile and hexachlorocyclopentadiene reactions as well as for the allene dimerization. The results lead to the conclusion that all [2 + 2] cycloaddition processes of allenes, including dimerizations, proceed via a multistep pathway, while the [2 + 3] and [2 + 4] cycloadditions proceed via concerted mechanisms. (auth)

40651 DISPROPORTIONATION VS. COMBINATION OF SECONDARY α-ARYL ALKYL RADICALS FROM THE THERMOLYSIS OF AZO COMPOUNDS IN SOLUTION. Gibian, Morton J.; Corley, Robert C. (Univ. of California, Riverside). J. Amer. Chem. Soc.; 94: No. 12, 4178-83(14 Jun 1972).

A study of the ratios of rate constants for self-disproportionation to combination (k_d/k_c) of a series of secondary aralkyl radicals ($p\text{-}XC_6H_4\dot{C}HR$) as a function of structure and conditions was carried out by thermal decomposition of the appropriate symmetrical azo compounds. At 118°C and for R = CH_3, variation of X including CH_3, H, and OCH_3 had a small effect on k_d/k_c, but for the p-Cl radical the ratio doubled. Benzene, acetonitrile, and N,N-dimethylaniline as solvents gave very similar results for the unsubstituted and p-methyl-α-phenethyl radicals (R = CH_3). For X = H, variation of R over a range of groups produced significant changes in k_d/k_c at 118°C with little obvious correlation with either the number of β hydrogens available for abstraction or with the stability of olefin to be formed in disproportionation (i.e., primary, secondary, tertiary, and various substituted secondary centers β to the benzylic radical). Comparison of the $Ph\dot{C}HCH_3$ to $Ph\dot{C}HCD_3$ radicals showed that $(k_d/k_c)(H)/(k_d/k_c)(D) = 1.87$. It is concluded that this must be largely a primary kinetic isotope effect on disproportionation. The k_d/k_c ratios for $Ph\dot{C}HCH_3$, $Ph\dot{C}HCD_3$, $Ph\dot{C}HCH_2CH_3$, and $Ph\dot{C}HCH(CH_3)_2$ were measured at three temperatures, yielding fairly linear inverse temperature vs. log (k_d/k_c) relationships. The respective data are: $\Delta H_c^\ddagger - \Delta H_d^\ddagger$ = 1.47, 0.80, 1.89, and 2.60 kcal mol; $\Delta S_c^\ddagger - \Delta S_d^\ddagger$ = 8.4, 7.7, 9.2, and 13.0 eu. Statistical factors, olefin (from disproportionation) stability, geometric requirements, and solvent have significant effects on the fate of caged radicals, and any or all of these factors may cause profound variations in k_d/k_c. (auth)

40652 KINETICS AND MECHANISM OF THE BAEYER–VILLIGER REACTION OF BENZALDEHYDES WITH PERBENZOIC ACIDS. Ogata, Yoshiro; Sawaki, Yasuhiko (Nagoya Univ., Japan). J. Amer. Chem. Soc.; 94: No. 12, 4189-96(14 Jun 1972).

The Baeyer–Villiger (B–V) reaction of benzaldehydes with perbenzoic acids to give phenols and/or acids was studied kinetically at various pH's in 40% aqueous ethanol. The pH dependence of the rate differs significantly with each substituent in the aldehydes. The pH-products profile shows a break at pH 8 to 9 and a slight acid catalysis for aryl migration at pH <1. Kinetic isotope effects for benzaldehyde-1-d resulted in k_H/k_D = 1.4 to 3.0 for hydride migration and 1.0 for aryl migration. The effect of substituents in perbenzoic acids affords ρ values of ca. 0.3 to 0.4 for most benzaldehydes, while $\rho \sim 0$ for o- and p-hydroxybenzaldehydes at pH >9. Relative migratory aptitude from the product ratios indicates a large negative ρ value of −4 to −5 (σ^+) for aryl migration, and that electron-releasing ortho substituents accelerate aryl migration ca. ten times as fast as the para isomers, revealing the relative unimportance of steric effect. These results are summarized by a mechanism where a rate-determining step changes from carbonyl addition to a migration step with changing substituents in the aldehydes, anisaldehyde being a borderline case. The nature of hydride and aryl migration is discussed on the basis of these data. (auth)

Isotope Exchange and Isotope Separation

40653 KINETICS OF OXYGEN EXCHANGE IN THE SYSTEM BrO_3^-–H_2O (D_2O). Gamsjaeger, H.; Gruetter, A.; Baertschi, P. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Helv. Chim. Acta; 55: No. 3, 781-9 (1972).

The kinetics of oxygen exchange between water (H_2O, D_2O) and ^{18}O-labeled bromate ions were investigated over the range of $1.7 \leq pH \leq 14.3$ and $20 \leq °C \leq 95$. At 60° and ionic strength $I \simeq 1.0M$ ($NaNO_3$), the experimental results were consistent with the rate laws (R in mole l^{-1} s^{-1}): $R = [BrO_3^-]\{1.59 \cdot 10^{-6} + 8.1 \cdot 10^{-7}[OH^-] + 0.122[H^+]^2\}$ in H_2O and $R = [BrO_3^-]\{4.69 \cdot 10^{-7} + 4.1 \cdot 10^{-7}[OD^-] + 0.378[D^+]^2\}$ in D_2O. From the temperature dependence of the rate constants the activation parameters $\Delta H^\ddagger$, $\Delta S^\ddagger$ and $\Delta C^\ddagger$ were derived. In the acid-catalysed region the form of the rate law and the direction of the solvent isotope effect were the same as previously found, but the numerical values of $\Delta H^\ddagger$ and k_{2H}/k_{2D} differ considerably. For the spontaneous and the OH^--catalysed exchange reactions bimolecular displacement mechanisms are proposed. (auth)

40654 HYDROGEN–DEUTERIUM EXCHANGE IN 1,4,5- AND 1,3,5-TRIMETHYLTETRAZOLIUM IODIDES. Isida, Tyuzo; Fujimori, Shin-ichiro; Nabika, Kiyoshi; Sisido, Keiiti; Kozima, Sinpei (Kyoto Univ.). Bull. Chem. Soc. Jap.; 45: No. 4, 1246-7(Apr 1972).

The C–H/C–D exchange of methyl protons in 1,4,5- and 1,3,5-trimethyltetrazolium iodides in basic D_2O solutions containing pD buffer mixtures was studied. There was no exchange of the N-methyl protons of the 1,4,5- compound, but the 1,3,5- compound showed H/D exchange. (M.C.G.)

40655 HYDROGEN EXCHANGE REACTIONS BETWEEN OLEFINS OR AN OLEFIN AND MOLECULAR HYDROGEN OVER ALUMINA STUDIED BY MICROWAVE SPECTROSCOPY. Sakurai, Yuzo; Onishi, Takaharu; Tamaru, Kenzi (Tokyo Univ.). Bull. Chem. Soc. Jap.; 45: No. 4, 980-3(Apr 1972).

The exchange reaction between propylene and deuterium was studied over alumina. The rate of the reaction was expressed by $V_{ex} = k[P_{D2}]^{0.5}[P_{Pro}]^{0.0}$. In the initial stages of the reaction the cis- and trans-1-d_1 species of propylene were the only products of the exchange reaction, but the concentration of the 3-d_1 species increased continuously as the reaction progressed. The activation energy for the exchange reaction was about 8.2 kcal/mol. Propylene-cis-d_1 was reacted over alumina, and the variation in the deuterium distribution of the propylene was followed by macrowave spectroscopy. Isotope scrambling and "double-bond migration" occurred to considerable extents, while cis-trans equilibration between the two C_1 hydrogen positions proceeded even faster. In the reaction of propylene-3-d_1, the isotope mixing and "double-bond migration" were considerably slower than those of the cis-1-d_1 species. Cis- and trans-1-d_1 species were formed in equal amounts. The possible mechanism of these reactions is discussed on the basis of the results obtained. (auth)

40656 PHOTOCHEMICAL ISOTOPIC EXCHANGE BETWEEN ACETONE-^{18}O AND ACETONE-d_6. Yang, N. C.; Eisenhardt, William; Libman, Jacqueline (Univ. of Chicago). J. Amer. Chem. Soc.; 94: No. 11, 4030-2(31 May 1972).

Acetone-^{18}O and acetone-d_6 undergo photochemical isotopic exchange to give acetone and acetone-d_6-^{18}O. The quantum yields were calculated and the exchange may be catalyzed by a photoproduct formed during the irradiation. (M.C.G.)

40657 MECHANISM OF THE RADIATION-INDUCED ISOTOPIC EXCHANGE BETWEEN IODOBENZENE AND IODINE IN BENZENE. Elias, H.; Voss, H.; Wannowius, K. J. (Technische Hochschule, Darmstadt, Ger.). Z. Naturforsch.; 27b: No. 6, 725-6(Jun 1972). (In German).

For the isotope exchange between iodobenzene and benzene containing iodine induced by ^{60}Co γ radiation, the reaction mechanism was established. It was found that, during the exchange, the solvent plays an important role as energy transmitter. Because of its aromatic character, the excited benzene has a longer life expectancy than an excited aliphatic molecule. In an aliphatic solvent, therefore, a different mechanism of isotope exchange could be expected. To test this assumption, experiments with cyclohexane were performed which yielded inconclusive results. (H.B.G.)

Feed Materials Processing

40658 PROCESSING OF URANIUM ORES. **Browning, S. J.** (Davy-Ashmore Pty. Ltd., Melbourne). Aust. Mining; 64: No. 5, 48-52(May 1972).

The history of uranium ore processing is briefly reviewed and the main process routes: leaching; liquid–solid separation; extraction and purification of uranium from solution using either ion exchange or solvent extraction; precipitation of the uranium and separation; and drying before delivery to the refining plant, are discussed. (Australia)

40659 PROBLEMS OF PROCESSING URANIUM MINERALS. **Otero, J. L.; Josa, J. M.** (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid); 15: No. 74, 464-79(Nov-Dec 1971). (In Spanish).

After a general review of the need of uranium in the world and in Spain, in the near future and long-term, the conventional processes for the processing of uranium minerals are examined. The most important steps of the various processes are shown diagrammatically. The installation costs for different production capacities and the operational costs are allocated. Possible improvements in the beneficiation are described. The Spanish situation is examined both from the viewpoint of the uranium reserves and the present and future capacity for the production of concentrates. The Andujar Fabrica de Uranio, the leaching installations of Salamanca, and the designed Fabrica de Uranio are described. (tr-auth)

Radiation Chemistry

Refer also to abstracts 40693, 41464, and 42393.

40660 (PEL-217) RADIATION-INDUCED COPOLYMERIZATION OF CHLOROTRIFLUOROETHYLENE WITH ETHYL VINYL ETHER. **du Plessis, T. A.** (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Nov 1971. 16p. Dep. NTIS (U. S. Sales Only).

The radioinduced copolymerization of chlorotrifluoroethylene with ethyl vinyl ether was investigated in the liquid phase at 20 and −78°C over a wide range of monomer compositions. A copolymer was obtained in which the monomers alternate with nearly perfect regularity along the polymer chain over the entire range of monomer compositions investigated. Both the rate of copolymerization and the molecular weight of the resulting copolymer were found to depend strongly on the initial monomer composition. Both reached a maximum value at an equimolar concentration of monomers. The monomer reactivity ratios were determined and compared with calculated values for the system based on the copolymerization parameters for the two monomers. It was found that a decrease in the irradiation temperature was accompanied by a marked decrease in the rate of copolymerization and the molecular weight of the copolymer. (auth)

40661 TRAPPING EFFICIENCY FOR ELECTRONS IN POLAR GLASSES AT 77°K. **Sawai, Takeshi; Shinozaki, Yoshiharu; Meshitsuka, Gisuke** (Tokyo Metropolitan Isotope Research Center). Bull. Chem. Soc. Jap.; 45: No. 4, 984-7(Apr 1972).

The trapped electron yields in alcohols and methanol–water mixtures at 77°K as a function of electron scavenger concentration were measured. The reciprocal of the trapped electron yield increased linearly with the concentrations of phenol, acetone, and acrylamide. The relative trapping efficiency for electrons increased with an increase in the dielectric constant of the matrix at room temperature. The relative traveling distance of electrons in these matrices was also estimated. (auth)

40662 RADIOLYSIS OF MIXTURES OF HYDROCARBONS AND AMMONIA. I. FORMATION OF ETHYLAMINE FROM A MIXTURE OF ETHYLENE AND AMMONIA. **Tokunaga, Okihiro; Hamanoue, Kumao; Okamoto, Jiro; Danno, Akibumi** (Japan Atomic Energy Research Inst., Tokai). Bull. Chem. Soc. Jap.; 45: No. 4, 1050-4(Apr 1972).

The γ radiolysis of a gaseous mixture of ethylene and ammonia was investigated over the whole range of composition. The products of decomposition were primarily hydrogen, ethane, n-butane, ethylamine, and acetylene. The yields of ethane, n-butane, and ethylamine increased with the increasing concentration of ammonia, and the G-values of these products at 98 mol % ammonia were 0.52, 2.12, and 0.89, respectively. Addition of oxygen or nitric oxide as radical scavengers tended to reduce the yields remarkably. The G-value of ethyl radical was calculated from the G-values of ethane, n-butane, and ethylamine, and the limiting value of $G(C_2H_5\cdot)$ was determined by extrapolation to 100 mol % ammonia. The value thus obtained agrees with the initial G-value of hydrogen radical, i.e., $G_H = 7.0 \pm 0.6$, which was obtained by Eyre and Smithies in the study of the γ radiolysis of ammonia gas. From these results, it was concluded that thermal hydrogen radicals produced by the γ radiolysis react quickly with ethylene, giving ethane, n-butane, and ethylamine from ethyl radicals. (auth)

40663 RAMAN SPECTRA OF IRRADIATED $NaClO_3$ AND $KClO_3$ CRYSTALS. **Radhakrishna, S.; Karguppikar, A. M.** (Indian Inst. of Tech., Madras). Proc. Indian Acad. Sci., Sect. A; 75: No. 3, 132-7(Mar 1972).

Pure undamaged $NaClO_3$ and $KClO_3$ crystals show four Raman lines arising from the internal oscillations in the ClO_3 ion, besides a few other Raman lines due to lattice oscillations. On radiation damage by x rays or γ rays, some new lines are observed in each crystal. In particular, two lines at ~680 and ~930 are assigned to the ozonide ion (O_3^-) in these lattices. It is postulated that after irradiation, a certain number of ClO_3 ions, which initially have a pyramidal structure, lose the chlorine atom, leaving the three oxygen atoms at the corners of an equilateral triangle. Since an equilateral triangular structure should exhibit two normal oscillations, both of which are Raman-active, such a postulate satisfactorily explains experimental results. (auth)

40664 ELECTRON SPIN RESONANCE STUDY OF X-IRRADIATED HEPTANAL OXIME TRAPPED IN A UREA INCLUSION CRYSTAL. EVIDENCE OF A BIMOLECULAR REACTION PRODUCT. **Birrell, G. Bruce; Ciecierska-Tworek, Zofia; Griffith, O. Hayes** (Univ. of Oregon, Eugene). J. Phys. Chem.; 76: No. 13, 1819-24(22 Jun 1972).

Free radicals trapped in x-irradiated heptanal oxime–urea inclusion crystals were investigated using electron spin resonance techniques. In addition to an iminoxy radical, $R{-}CH{=}NO^{\cdot}$, two secondary radicals were observed. Spectral simulations and a table of coupling constants and g values are presented. ESR spectra and selective deuteration suggest that the secondary radicals are of the type $R{-}N{-}R'$ and $RR'NO$. (auth)

40665 PULSE RADIOLYSIS STUDIES ON Br^- IN AQUEOUS SOLUTION: THE MECHANISM OF Br_2^- FORMATION. **Behar, D.** (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 76: No. 13, 1815-18(22 Jun 1972).

The reaction of hydroxyl radicals with Br^- was investigated in the pH regions 9 to 11.5. The maximum absorption of Br_2^- was followed spectrophotometrically at 365 nm as a function of $[Br^-]$ and $[OH^-]$. The intermediate species, $BrOH^-$, is suggested as a precursor in the oxidation mechanism of Br^-. (auth)

40666 MOESSBAUER STUDY OF SOME GAMMA- AND NEUTRON-IRRADIATED IRON CARBONYL COMPLEXES. **Cheng, H. S.** (Tsing Hua Univ., Hsinchu, Taiwan); **Yeh, S. J.; Cheng, P. K.** J. Chin. Chem. Soc. (Taiwan); 18: No. 4, 179-88(Dec 1971).

Moessbauer effect experiments were carried out on ^{60}Co- and reactor-irradiated $[Fe(CO)_3SCH_3]_2$, $[(C_4H_9)SnFe(CO)_4]_2$, $(C_6H_5)_3PFe(CO)_4$, $(CH_2)_4[Fe(CO)_2C_2H_5]_2$, and $(CH_2)_4(CO)_2[Fe(CO)_2C_5H_5]_2$. It was found that the Fe–CO bond is more radiation-resistant than was expected due to the π bonding character. The σ bonds, such as C–H, are labile to radiation. The presence of an acyl carbonyl group increases the radiation-resistant property of the molecule. The increase in the isomer shift values of the complexes with cyclopentadienyl groups was interpreted to be the result of dehydrogenation. (auth)

40667 LOW-DENSITY LIMIT OF STABILITY OF SOLVATED ELECTRONS IN SUPERCRITICAL AMMONIA. **Olinger, R.; Hahne, S.; Schindewolf, U.** (Univ., Karlsruhe, Ger.). Ber. Bunsenges. Phys. Chem.; 76: No. 3-4, 349-50(Apr 1972).

Pulse radiolysis of supercritical ammonia yields solvated electrons in the solvent density range down to 10 mol ammonia vapor per liter (0.2 g/cm^3). The absorption spectrum has about the same form and the same position as in normal liquid ammonia at lower temperature. Below the given density limit, solvated electrons could not be detected. (auth)

40668 POLYMERISATION OF ETHYLENE UNDER THE INFLUENCE OF GAMMA IRRADIATION. PART I. HIGH-PRESSURE GAS-PHASE POLYMERISATION. **Thomas, A. C.; Basson, R. A.** (Atomic Energy Board, Pretoria). J. S. Afr. Chem. Inst.; 25: No. 1, 44-52(1972).

The effect of pressure, temperature, and radiation intensity upon the gamma-induced polymerization of ethylene in the gas phase was determined. The polymer produced under the different conditions has been characterized in terms of molecular weight, infrared spectrum, density, and crystalline melting point. (auth)

40669 USE OF A NUCLEAR REACTOR FOR THE PROCESS OF VAPOR PHASE RADIATION–THERMAL OXIDATION OF BENZENE. Dobrovol'skii, S. P.; Timofeev, V. D.; Zakharova, I. V.; Yur'ev, Z. N. This paper was summarized in At. Energ. (USSR); 31: No. 1, 50(Jul 1971) as paper No. 504/5941. (In Russian).

Full copy of this paper is held by TIC.

A technological scheme is discussed for the production of phenol using reactor radiation. Possible nuclear–chemical reactors, operating either with the coolant and reagent loops separate and the reagent playing no part in the heat removal or the reagent also in the coolant, are a water-moderated water-cooled reactor, with heat-insulated channels for the reagents placed at uniform intervals in the active zone, and a high-temperature reactor with a charge of spherical BeO-based fuel elements cooled by the reagent mixture. Engineering and physical calculations show that for a thermal power of 350 to 400 MW, reactors of either type can provide a phenol output of 10^5 tons/yr. (D.H.M.)

40670 ELECTRON SPIN RESONANCE OF γ-IRRADIATED ACETYLACETONE IN ADAMANTANE MATRIX. Wolodarsky, W. H.; Wan, J. K. S. (Queen's Univ., Kingston, Ont.). Can. J. Chem.; 50: No. 7, 1096-8(1 Apr 1972).

Electron spin resonance spectrum is observed when samples of solid adamantane doped with acetylacetone are γ-irradiated at room temperature. The spectrum is interpreted due to an enolized allylic radical $CH_3COCHC(OH)CH_2$. (auth)

40671 ESR AND THERMOLUMINESCENCE OF C_2Cl_6. Bettinali, Carlo; Guidoni, Laura (CNEN, Rome. Univ., Rome). Z. Phys. Chem. (Frankfurt); 78: No. 12, 17-25(Apr 1972).

The relation between thermoluminescence and ESR in C_2Cl_6 as microcrystalline powder and as single crystals was investigated. The presence of three types of radicals was detected in γ-irradiated C_2Cl_6. A four-line radical, which is stable at low temperature, occurs at the surface and can be related to ClO_2 or Cl_2^- in axial symmetry. The single line radicals, which are stable at room temperature, can be tentatively related to $Cl^\cdot$ and $C_2Cl_5^\cdot$. The annealing of radicals seems to be strictly related to thermoluminescence emission. (auth)

40672 LUMINOL CHEMILUMINESCENCE INDUCED BY INTERNAL IRRADIATION. Nikokavouras, J.; Mantaka, A. E.; Marketos, D. G.; Rakintzis, N. Th.; Vassilopoulos, G. (Democritus Nuclear Research Center, Athens). Z. Phys. Chem. (Frankfurt); 78: No. 1-2, 76-8(Apr 1972).

A 22-fold increase in the efficiency of the luminol light-reaction is observed when the aqueous system "luminol–hydrogen peroxide–potassium ferricyanide–alkali" is replaced by the aqueous system "luminol–alkali–^{32}P". (auth)

40673 CALCULATION OF MAGNITUDES OF CHEMICALLY INDUCED DYNAMIC ELECTRON POLARIZATION. Pedersen, J. Boiden; Freed, Jack H. (Cornell Univ., Ithaca, N. Y.). J. Chem. Phys.; 57: No. 2, 1004-6(15 Jul 1972).

It is possible to perform a rigorous analysis of the electron-spin polarization generated by the radical-pair mechanism in irradiated liquids by the stochastic Liouville method. Typical results of the limiting polarization are given for a range of values of the relevant parameters. (M.C.G.)

40674 RADIATION CHEMISTRY OF NUCLEIC ACIDS. ISOLATION AND CHARACTERIZATION OF THYMINE GLYCOLS. Hahn, Bo-sup; Wang, Shih Yi (Johns Hopkins Univ., Baltimore). J. Amer. Chem. Soc.; 94: No. 13, 4764-5(28 Jun 1972).

The chemistry of cis and trans forms of 5,6-dihydroxy-5,6-dihydrothymines formed by γ radiolysis of thymine was studied. Aqueous solutions of thymine were irradiated and these compounds identified and a mechanistic explanation of the reactions given. (M.C.G.)

40675 ELECTRON SCAVENGING STUDIES IN THE GAMMA-RADIOLYSIS OF PYRIDINE AND TETRAHYDROFURAN. Rao, K. N.; Goyal, G. C.; Ramanan, G. (Bhabha Atomic Research Centre, Trombay, India). Radiat. Eff.; 14: No. 1-2, 101-7 (May 1972).

γ-radiolysis of pyridine and tetrahydrofuran (THF) containing nitrous oxide concentration was studied. Hydrogen and nitrogen yields at different nitrous oxide concentrations were measured in pyridine or THF. Nitrogen yields in pyridine or THF containing nitrous oxide and a second electron scavenger such as benzene, bromobenzene, acetophenone, benzaldehyde, benzonitrile, nitrobenzene or carbon tetrachloride were estimated and used in calculating the reactivities of these solutes towards solvated electrons. (auth)

40676 HAZARDS OF IRRADIATED LIQUID NITROGEN: A BRIEF BIBLIOGRAPHY. Perdue, P. T. (Oak Ridge National Lab., Tenn.). Health Phys.; 23: No. 1, 116-17(Jul 1972).

A brief discussion is given on the dangers attendant on irradiation experiments using liquid nitrogen containing oxygen as impurity, followed by a bibliography of 17 references, in an attempt to increase general awareness of the problem. (UK)

40677 DOSE RESPONSE RELATIONSHIP OF FREE RADICALS AT HIGH DOSES OF GAMMA-IRRADIATED AMINO ACIDS AND DIPEPTIDES. Kushelevsky, A. P.; Slifkin, M. A. (Univ. of Salford, Eng.). Radiat. Eff.; 14: No. 1-2, 67-70(May 1972).

Free radical saturation at high doses was confirmed for the γ-radiolysis of some amino acids and dipeptides. Spectral changes were observed for the electron spin resonance signals from irradiated polycrystalline glycylglycine at high doses. The mechanisms proposed to explain the saturation phenomenon were examined and found to be incomplete. A new model is tentatively proposed to explain both the saturation and the spectral changes. (auth)

40678 NATURE OF RADICALS FORMED DURING RADIOLYSIS OF FROZEN AQUEOUS SOLUTIONS OF GLUCOSAMINE. Nadzhafova, M. A.; Sharpati, V. A.; Emanuel, N. M. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 202: No. 1, 128-31(Jan 1972). (In Russian).

Glucosamine (indexed as 2-amino-2-deoxyglucose) solutions were irradiated at doses from 1 to 6 MR at 77°K, and EPR spectra were used to detect the presence of free radicals formed by the radiolysis. In the three media, 10M KOH, 2.5 and 5M NaH_2PO_4, and water, ten paramagnetic particles were identified, including OH, H_2O^+, $H_2PO_4^-$, and O^-. (K.S.W.)

40679 ELECTRON SPIN RESONANCE STUDIES OF IRRADIATED POTASSIUM HEXACYANOCOBALTATE(III) IN VARIOUS HOST LATTICES. Symons, M. C. R.; Wilkinson, J. G. (Univ. of Leicester, Eng.). J. Chem. Soc., Dalton Trans.; No. 10, 1086-90(1972).

ESR results for γ-irradiated $K_3Co(CN)_6$ in a wide range of alkali metal halide matrices are reported. The main paramagnetic species detected at 77°K were the pentacyanocobaltate(II) ion $[Co(CN_5)]^{3-}$, and the "di-isocyanide" $[Co(CN)_4(NC)_2]^{4-}$, but various halogen-substituted complexes were formed in low concentrations. On annealing, the "di-isocyanide" complexes were lost, probably by reaction with V_K centers, but the remainder were stable well above room temperature. The form of the g- and A-tensors is discussed, and it is suggested that the "di-isocyanide" complex probably contains two off-axis cyanide ions twisted through relatively small angles, rather than through 180° as previously postulated. (auth)

40680 RADIATION AND POLYMERS. Sangster, D. F. (Australian Atomic Energy Commission Research Establishment, Sutherland). Proc. Roy. Aust. Chem. Inst.; 39: No. 4, 110-15 (Apr 1972).

Current aspects of radiation in polymer science are briefly surveyed. High-energy ionizing radiation on an industrial scale is obtained from either isotopic sources or electron accelerators. Monomers under this influence form either bulk, graft, or copolymers; polymers undergo degradation and crosslinking. Crosslinking of polymers such as polyethylene by doses of 10 to 30 Mrad is a convenient means of inducing either greater high-temperature resistance or the memory effect. Other applications of radiation are in the vulcanization of rubber, the curing of surface finishes and coatings; the production of wood–plastic and other composites; the improvement of crease resistance and soil release properties of polyester cotton by radiation treatment in durable-press finishing; and the production of the grafted copolymer of polyethylene and acrylics for use as a battery separator. Other applications of post-irradiation polymerization and graft copolymerization are described. (Australia)

40681 ELECTROCONDUCTIVITY OF LIQUID AMMONIA DURING PULSED IRRADIATION BY FAST ELECTRONS. Khaikin, G. I.; Zhigunov, V. A.; Dolin, P. I. (Inst. of Electrochemistry, Moscow). Dokl. Akad. Nauk SSSR; 202: No. 1, 140-2(Jan 1972). (In Russian).

Samples of liquid ammonia were exposed to 2-μsec pulsed beams (120 mA) of electrons in doses varying from 500 to 2,000 R. The formation of charged particles caused a reversible increase in the electric conductivity of the samples. The initial current of the charge carriers was directly proportional to the electrode potential. (K.S.W.)

40682 ESR SPECTRA OF RADICAL PAIRS IN IRRADIATED ORIENTED POLYETHYLENE. Fujimura, Takashi; Tamura, Naoyuki (Japan Atomic Energy Research Inst., Takasaki). J. Polym. Sci., Part B; 10: No. 6, 469-71(Jun 1972).

A well-defined structure in the $\Delta M_s = 1$ spectrum of radical pairs in a drawn film of polyethylene was observed. High-density polyethylene strips were drawn to an elongation of about 1000%. Irradiations were performed with 2-MeV electrons at a dose rate of 0.16 Mrads/sec. Spectra are shown for cases of parallel and perpendicular magnetic fields. (M.C.G.)

40683 GAMMA-RADIATION EFFECTS ON POLYMERS. III. GRAFTING OF STYRENE ON POLY(ETHYLENE TETRACHLORO-o-PHTHALATE) IN THE PRESENCE OF ORGANIC SOLVENTS. Ghanem, N. A. (National Research Centre, Cairo); El-Azmirly, M. A.; Aly, M. I. Eur. Polym. J.; 8: No. 1, 195-205(Jan 1972).

Poly(ethylene tetrachloro-o-phthalate), a polyester from ethylene glycol and tetrachlorophthalic anhydride, was irradiated in the presence of styrene, styrene–dioxane, and styrene–n-hexane. The experimental data indicate that, in the presence of some organic solvents, styrene was grafted on the polyester; the type of branching depended on the solvent. In their absence, styrene was mainly homopolymerized. The extent of grafting was related to the nature of solvent and to the G value for hydrogen production of the polymer additive. (auth)

40684 INFLUENCE OF γ-IRRADIATION ON THE TRANSITION TEMPERATURES OF CRYSTALLINE POLYTETRAFLUORETHYLENE. Kusy, R. P. (Drexel Univ., Philadelphia); Turner, D. T. J. Polym. Sci., Part A-1; 10: No. 6, 1745-62(Jun 1972).

The influence of γ irradiation on the melting and two solid–solid transitions, occurring near 19° and 30°C, of poly(tetrafluorethylene) was studied by differential scanning calorimetry. A continuous depression of all three transition temperatures with increasing dose was observed in a first scan of highly crystalline samples at a heating rate of 20°C/min. Additional information was obtained about the accompanying heats of transition. Values for the number of CF_2 units excluded from the crystal lattice per 100 eV energy deposition were calculated by using an equation for the depression of the melting point by chemical impurities. The value obtained of $G(\text{–units}) = 3.3 \pm 0.3$ is in agreement with a value of $G(\text{chemically damaged units}) = 3.0 \pm 0.1$ previously reported on the basis of scavenging techniques. It is concluded that chemical radioinduced damage in this polymer may be estimated by reference to changes in the melting temperature. A value of $G(\text{–units}) = 1.6 \pm 0.2$ was obtained by reference to the 19°C transition. (auth

40685 RELATION BETWEEN FREE RADICALS AND ULTRAVIOLET ABSORPTION IN POLY(METHYL METHACRYLATE). ten Bosch, J. J. (State Univ., Utrecht); Verhelst, W. F.; Chadwick, K. H. J. Polym. Sci., Part A-1; 10: No. 6, 1679-85(Jun 1972).

A correlation between the radioinduced nine-line electron spin resonance signal and the unstable component of the optical absorption in the near ultraviolet in poly(methyl methacrylate) is made on the basis of the radiation-dose relationship, the dependence of production on irradiation temperature at a constant radiation dose, and on the fading of both signals on oxygen diffusion into the poly(methyl methacrylate) after irradiation. It is concluded that this correlation is applicable only immediately after irradiation and the stability of the initial radical is discussed with respect to the fading results. A process of radical decay and conversion is suggested to account for differences found in the fading characteristics of the two signals. (auth)

40686 EFFECT OF AMOUNT OF MEDIUM ON THE RADIATION-INDUCTED POLYMERIZATION OF ETHYLENE IN TERT-BUTYL ALCOHOL. Wada, Takeshi; Watanabe, Terutaka; Takehisa, Masaaki (Japan Atomic Energy Research Inst., Takasaki). J. Polym. Sci., Part A-1; 10: No. 6, 1655-67 (Jun 1972).

The kinetics of the radioinduced polymerization of ethylene in the presence of various amounts of medium (tert-butyl alcohol containing 5 vol-% of water) was studied, and the effect of the amount of medium on the polymerization was investigated. The polymerization was carried out by use of a reactor of 100 ml capacity under the following conditions: temperature, 24 ± 3°C; pressure, 200 kg/cm^2; dose rate, 2.0×10^4 to 1.6×10^5 rad/hr. The amount of polymerized monomer and the rate of polymerization were maximum when about 50 ml of the medium was used. Data obtained with the use of 30, 50, and 90 ml of the medium were analyzed kinetically and the rate constants of each elementary reaction were determined by the method based on a reaction mechanism which contains both first- and second-order terminations for the concentration of propagating radical. These results were compared with those obtained with the use of 70 ml of the medium already reported in a previous paper. The dose rate exponents of the rate of polymerization were about 0.7 to 0.8. It was found that G values for the initiation of ethylene and the medium were 1.5 and 3.8, respectively, and the rate of propagation was proportional to the fugacity of ethylene. It is supposed that the medium plays an important role in the first-order termination, because the apparent rate constant of the reaction was larger when a larger amount of medium was used. (auth)

Radiochemistry and Nuclear Chemistry

40687 STATE OF ^{129}Te IMPURITY ATOMS IN ALKALI HALIDES USING MOESSBAUER SPECTROSCOPY. Seregin, P. P.; Savin, E. P. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 11, 2846-9(May 1972).

Translated from Fiz. Tverd. Tela; 13: No. 11, 3388-92(Nov 1971).

Moessbauer emission spectroscopy was used to study the state of ^{129}Te atoms in LiCl, NaCl, and KCl. Tellurium enters the alkali halides both as Te^{+4} and Te^{+6}, in which the fraction of Te^{+6} atoms is maximum in NaCl and minimum in LiCl. The local surroundings of the Te^{+6} atoms are nearly cubic while the spectrum of $^{129}Te^{+4}$ (^{129}I) has quadrupole splitting (eqQ = 30 ± 3 mm/sec). (auth)

40688 EFFECT OF AN EXTERNAL ELECTRIC FIELD ON THE DECAY CONSTANT OF ^{99m}Tc IN HALOGEN COMPLEXES. Leuenberger, H.; Huber, P.; Nyikos, P.; Kobel, H. R.; Seiler, H. (Univ., Basel); Helv. Chim. Acta; 55: No. 3, 961-9(1972).

A positive change $\Delta\lambda/\lambda$ of the decay constant of ^{99m}Tc was observed on the application of an external electric field in K_2TcX_6 (X = F, Cl, Br, I). For its investigation the Tc complexes were embedded as small conglomerates or more or less as isolated single molecules in a powder of high dielectric constant, which was then compressed into a thin layer of about 0.2 mm and inserted between two capacitor plates. The change $\Delta\lambda/\lambda$ depends on the strength of the chemical bond of ^{99m}Tc. As a first approximation $\Delta\lambda/\lambda$ was assumed to be linearly dependent upon the electric field. The experimental results with an external field of 10^4 V/cm are tabulated. A relation between $\Delta\lambda/\lambda$ and the electronegativities of the ligand atoms could be established. Difficulties encountered in the theoretical calculation of $\Delta\lambda/\lambda$ are discussed. (auth)

40689 NEW TYPE OF TREASURY FOR RADIOACTIVE SUBSTANCES. Hoefer, O.; Bullinger, Th.; Troebs, G. (Univ., Munich). Strahlentherapie; 143: No. 4, 424-31(Apr 1972). (In German).

An automatic carousel for storing radioactive substances is described. It has the capacity to store numerous nuclides and particular preparations. Each nuclide or preparation can easily be identified. The content of the treasury is clearly signaled by means of a luminous board, whose signalizing criteria are attained by measuring the radiation of the individual preparations or nuclides. (auth)

40690 RADIOCHEMICAL HYDROLYSIS OF RADIOACTIVE CERIUM OXALATE. Spitsyn, V. I.; Moshchanskaya, N. G. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 202: No. 2, 388-90(11 Jan 1972). (In Russian).

Doubly labeled cerium oxalate with specific activities of 0.02 mCi/g in ^{144}Ce and 0.03 mCi/g in ^{14}C was used to demonstrate that radiochemical hydrolysis occurred only upon dissolving the salt in water. This process was speeded up by a rise in temperature and the poorly soluble Ce hydroxy complexes formed. In an acid medium the reaction was reversible and hydrolysis ceased. Radiolysis of the oxalate ion was not observed under the conditions of the experiment. (K.S.W.)

40691 ABSOLUTE STANDARDIZATION OF ^{14}C BY DIFFERENTIAL GAS COUNTING. Khera, G. D.; Srivastava, P. K.; Gupta, U. C. (Bhabha Atomic Research Centre, Trombay, India). pp 203-8 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1971). See CONF-701138.

Length-compensated differential gas-counters were used for the absolute standardization of ^{48}C. A technique was developed for complete conversion of carbonates into CO_2 and for counting the evolved gas with practically 100% efficiency in internal gas counters. The method of preparation of $^{14}CO_2$ quantitatively from samples of barium carbonate and its purification is described. The internal gas counting of $^{14}CO_2$ and the applied corrections are also given. (auth)

40692 STANDARDIZATION OF ^{203}Hg BY USING 4π β−γ COINCIDENCE TECHNIQUE. Srivastava, P. K.; Khera, G. D.; Gupta, U. C. (Bhabha Atomic Research Centre, Trombay, India). pp 209-12 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1971). See CONF-701138.

Standards of ^{203}Hg were prepared by using the 4π β−γ coincidence technique. The activity of the bulk solution was determined to be (3.23 ± 0.23%) μCi/g. The technique used for the absolute standardization of ^{203}Hg is described. A precipitation method of source preparation was used. It improves the beta efficiency and avoids the difficulty of sublimation and creeping that is common to mercuric chloride and nitrate. (auth)

Hot-Atom Chemistry

40693 ^{60}Co RECOIL REACTIONS IN THE BENZENE SOLUTIONS OF TRIS(NITROSONAPHTHOLATO)COBALT(III). Tominaga, Takeshi; Sakai, Takuhiko (Tokyo Univ.). Bull. Chem. Soc. Jap.; 45: No. 4, 1237-8(Apr 1972).

A scavenger effect of metallic salts can be observed in the irradiated benzene solutions of the complex and the apparently high retentions in the solid complex may be ascribed to the thermal reactions taking place in solutions of the irradiated solid complexes. (M.C.G.)

40694 STEREOCHEMICAL COURSE OF A GAS-PHASE ELECTROPHILIC ATTACK AT SATURATED CARBON. REACTION OF meso-1,2-DICHLORO-1,2-DIFLUOROETHANE WITH GASEOUS BROENSTED ACIDS. Cacace, Fulvio; Speranza, Maurizio (CNR, Rome. Univ., Rome). J. Amer. Chem. Soc.; 94: No. 13, 4447-50(28 Jun 1972).

The gas-phase electrophilic attack of He^3H^+ ions from the β decay of molecular tritium on meso-1,2-dichloro-1,2-difluoroethane leads to the predominant formation of a tritiated product retaining the original configuration of the substrate, with a considerably smaller yield of the tritiated dl form. The effect of the substrate pressure on the meso/dl ratio and the use of radiolytically produced methanonium and ethyl ions as milder gas-phase Brønsted acids show that the minor yield of the dl form is likely to arise from a racemization process, rather than from a discrete mode of attack, leading to inversion. The conclusion that the gas-phase tritiodeprotonation proceeds with retention of the substrate configuration is compared with the theoretical predictions on the course of the SE2 substitution processes. (auth)

Properties of Radioactive Materials

Refer also to abstract 41323.

40695 (DOCKET-408027-9) SEQUOYAH URANIUM HEXAFLUORIDE PRODUCTION PLANT. Environmental Report, Supplementary. (Kerr-McGee Corp., Oklahoma City, Okla.). Jun 1972. 242p. Dep. NTIS.

More detailed and, in some instances, additional analyses of the environmental impact of the Sequoyah facility are presented in four general sections: plant site and surrounding area, the plant and its processes, the environmental impact, and a cost-benefit evaluation. (M.C.G.)

40696 (JINR-P6-6403) STUDY OF TRANSPLUTONIUM ELEMENT HYDROLYSIS. II. HYDROLYSIS OF AMERICIUM(III) IN PRESENCE OF IONS WITH POSITIVE AND NEGATIVE HYDRATION ENERGY. Korotkin, Yu. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

The hydrolysis of Am(III) ions in HNO_3 and $HClO_4$ solutions at $\mu = 0.1$ to 1 in the range pH = 1 to 11 was studied. Various effects of ions with positive and negative energy on the hydrolysis process are shown. (auth)

40697 (JINR-P6-6404) STUDY OF TRANSURANIUM ELEMENT HYDROLYSIS. III. AMERICIUM AND CURIUM HYDROLYSIS IN SOLUTIONS OF PURE NITRIC ACID. Korotkin, Yu. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

The mechanism of Am and Cm hydrolysis in pure HNO_3 up to $pH \leq 5.5$ was studied. Insertion of Li^+ and NH_4^+ ions into HNO_3 at $pH = \leq 2$ suppresses the hydrolysis and shifts the equilibrium to the production of the nitrate complexes. At low pH($\gtrless$4) the same operation produces the reverse action. (auth)

40698 (ORNL-tr-2382) DETERMINATION OF STABILITY CONSTANTS OF SOME ACTINIDE COMPLEXES. II. NITRATE AND CHLORIDE COMPLEXES OF URANIUM, NEPTUNIUM, PLUTONIUM, AND AMERICIUM. Lahr, H.; Knoch, W. Translated for Oak Ridge National Lab., Tenn., from Radiochim. Acta; 13: No. 1, 1-5(1970). 10p. Dep. NTIS.

The stability constants of the nitrato complexes of several actinides were determined under identical experimental conditions: U(IV), U(VI), Np(IV), Np(V), Np(VI), Pu(III), Pu(IV), Pu(VI), and Am(III). The ionic strength was held constant ($\mu = 8$) by the addition of $HClO_4$. A collection of known constants is given for comparison. A systematic relation between cationic radius, ionic charge, and complex strength within a series of actinides of equal valency or different oxidation states of one element could not be established. This was previously abstracted from the original language and the abstract appeared as NSA 24: 20757. (auth)

40699 DETERMINATION OF THE FIRST HYDROLYSIS CONSTANT OF FERMIUM. Hussonnois, H.; Hubert, S.; Aubin, L.; Guillaumont, R.; Boussieres, G. (Institut de Physique Nucleaire, Orsay, France). Radiochem. Radioanal. Lett.; 10: No. 4, 231-8(10 Jun 1972). (In French).

The first hydrolysis constant of fermium, K_1, was determined by a solvent extraction method. It was found that $\log K_1 = -3.8 \pm 0.2$. (auth)

40700 CITRIC COMPLEXES OF Pu(IV). Metivier, H. (CEA, Montrouge, France); Guillaumont, R. Radiochem. Radioanal. Lett.; 10: No. 4, 239-50(10 Jun 1972). (In French).

The complexing of Pu^{4+} ion and Pu(IV) hydrolyzed species by citric acid was studied by a solvent extraction method at $\mu = 1$, $C_{H_3Cit} < 10^{-1}M$, and $0 < pH \lesssim 7$. Citrato complexes of the first and second order were observed carrying charges from 3^+ to 4^-. Formation constants were computed. At pH 5 to 7 and for $C_{H_3Cit} \sim 0.1M$, $PuOCit_2^{4-}$ is the predominant species. (auth)

40701 BIODEGRADABLE RADIOACTIVE PARTICLES. Evans, Roger L. (to Minnesota Mining and Mfg. Co.). U. S. Patent 3,663,685. 16 May 1972. Filed 1 Apr 1968.

Particles, preferably substantially spherical particles having a smooth outer surface and essentially void-free interior, are produced, consisting essentially of solid, cold-water-insoluble vehicle comprising a physiologically acceptable, parenterally metabolizable protein or polysaccharide having dispersed therein a water-insoluble carrier loaded with radioisotopes. The particles are substantially non-leachable upon short term exposure to cold water. Such particles can be administered parenterally for diagnostic purposes, or for treatment with radioactive materials. On administration in this way, they are broken down or solubilized by the body fluids over a predeterminable period ranging from minutes to several days, whereupon the radioisotopic material is excreted from the body thus limiting exposure to the radiation. (auth)

40702 BIODEGRADABLE RADIOACTIVE PARTICLES. Grotenhuis, Ivan M.; Kubiatowicz, David O. (to Minnesota Mining and Mfg. Co.). U. S. Patent 3,663,686. 16 May 1972. Filed 24 Apr 1968.

Particles, preferably substantially spherical particles having a smooth outer surface and essentially void-free interior, are produced, consisting essentially of solid, cold-water insoluble vehicle comprising a physiologically acceptable, parenterally metabolizable radioactive protein. The particles are substantially non-leachable upon short term exposure to cold water. The particles can be administered parenterally for diagnostic, prophylactic or therapeutic purposes. On administration in this way, they are broken down or solubilized by the body fluids over a predeterminable period ranging from minutes to several days, whereupon the radioisotopic material is excreted from the body thus limiting exposure to the radiation. (auth)

40703 BIODEGRADABLE PARENTERAL MICROSPHERULES. Evans, Roger L. (to Minnesota Mining and Mfg. Co.). U. S. Patent 3,663,687. 16 May 1972. Filed 26 Jun 1968.

Tiny substantially spherular particles, having a smooth outer surface and essentially void-free interior, are produced consisting essentially of solid, cold-water-insoluble material comprising a physiologically acceptable, parenterally metabolizable protein. The spherules may be made radioactive after their preparation, and the radioactivity is substantially nonleachable upon short-term exposure to cold water. They can be used as carriers for substances, e.g., radioisotopes, which are administered parenterally for diagnostic, prophylactic, or therapeutic purposes. On administration in this way, they provide a predeterminable dwell time and thereafter are broken down or solubilized by the body fluids over a predeterminable period ranging from minutes to several days. Thereafter the radioisotopic or other material is excreted from the body thus terminating exposure to the carried substance. (auth)

40704 SOLUBILITY COEFFICIENTS OF ^{85}Kr and ^{133}Xe IN WATER, SALINE, LIPIDS, AND BLOOD. Kitani, K. (Rigshospitalet, Copenhagen). Scand. J. Clin. Lab. Invest.; 29: No. 2, 167-72(Apr 1972).

The solubility coefficients of ^{133}Xe and ^{85}Kr were determined in water, different lipids, and blood. Corrections for self-absorption and scatter in the measuring system were determined separately. Comparison with values previously obtained is made, and the application of the results is discussed. (auth)

40705 COAGULATION OF SILVER HALIDE SOLS BY URANYL COMPLEXES. Bleier, Alan (Clarkson Coll., Potsdam, N. Y.); Matijevic, Egon; McGuire, J.; Wear, J. O. J. Colloid Interface Sci.; 38: No. 3, 647-9(Mar 1972).

The critical coagulation concentrations (ccc), expressed as the molarity of uranyl ion, for a negatively charged silver iodide sol in statu nascendi (AgNO: 1 × 10 M; KI: 2 × 10 M) are given as a function of pH. Similar results were obtained with silver bromide and silver chloride sols. The general characteristic of the system is that at pH >~ 4 the ccc increases until the pH is sufficiently high for uranyl salt solution to show a precipitate in the absence of the silver halide sols (pH ~ 5.5, at the ccc of $UO_2(NO_3)_2$). Electrophoretic measurements show that the silver iodide sols remain negatively charged and the mobility changes very little over the entire pH range studied. Below pH ~ 4 the ccc for the uranyl salt is reasonably constant and its value is as expected for counterions of 2+ charge for the same sol. The increase in ccc with pH must be caused by the hydrolysis of the uranyl ion. (D.H.M.)

40706 REDUCTION OF FERMIUM TO THE DIVALENT STATE IN WATER-ETHANOL SOLUTIONS OF CHLORIDES. Mikheev, N. B.; Spitsyn, V. I.; Kamenskaya, A. N.; (and others) (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 201: No. 6, 1393-5(21 Dec 1971). (In Russian).

^{252}Fm was prepared in a heavy ion accelerator by the reaction $^{238}U(^{18}O, 4n)^{252}Fm$. After working up the product, the Fm was dissolved in an HCl−ethanol solution; samarium chloride solution, which also contained ^{85}Sr and Mg metal in HCl for purposes of reduction, was added. The difficultly soluble $SmCl_2$ was formed and entrained ^{85}Sr and $^{252}Fm^{2+}$. The potentials of $Sm^{2+} \rightleftharpoons Sm^{3-} + e$ and $Fm^{2+} \rightleftharpoons Fm^{3+} + e$ are discussed; the presence of Fm(II) was confirmed. (K.S.W.)

40707 KINETICS AND MECHANISM OF THE OXIDATION OF Np(V) BY Ce(IV). Ekstrom, A.; McLaren, A. (Australian Atomic Energy Commission, Sydney). J. Inorg. Nucl. Chem.; 34: No. 6, 2015-22(Jun 1972).

The kinetics of the oxidation of Np(V) by Ce(IV) have been studied in perchlorate media using stop-flow techniques. At an ionic strength of 2.0, the rate of disappearance of Ce(IV) is first order with respect to the Np(V) and Ce(IV) concentrations, and is essentially first order with respect to the hydrogen ion concentration. The activation energy parameters of the reaction are determined and the reaction mechanisms consistent with the observed rate laws are discussed. (auth)

40708 EFFECT OF SURFACTANTS ON THE POLAROGRAPHIC REDUCTION OF HEXAVALENT URANIUM IN SULPHURIC ACID SOLUTIONS. Issa, I. M.; Tharwat, M. (Assiut Univ., Egypt). Electrochim. Acta; 17: No. 7, 1285-97(Jul 1972).

The effect of cationic, anionic and non-ionic surfactants (SAS) on the kinetics of polarographic reduction of U(VI) in sulphuric acid solutions of different concentrations were investigated. Both anionic and non-ionic surfactants cause retardation of the reduction process and render the waves more irreversible. A cationic SAS showed an opposite effect. Evaluation of the kinetic parameters was made. The effects vary with the acid or SAS concentration. (auth)

40709 CHEMISTRY OF THE TRIVALENT ACTINIDES. PART I. URANIUM(III) SULPHATES AND DOUBLE SULPHATES. Barnard, R.; Bullock, J. I.; Larkworthy, L. F. (Univ. of Surrey, Guildford, Eng.). J. Chem. Soc., Dalton Trans.; No. 8-9, 964-70(1972).

The first-known hydrated compounds of uranium(III) were prepared as sulphates and double sulphates and characterized by magnetic and spectral measurements. (auth)

40710 PROBLEMS IN PLUTONIUM CHEMISTRY: TEMPERATURE STABILITY OF Pu(V) AND THE QUADRUPLE POINT. Silver, G. L. (Mound Lab., Miamisburg, Ohio). J. Inorg. Nucl. Chem.; 34: No. 6, 1857-60(Jun 1972).

The concept of representing plutonium in aqueous solutions as distributed among four oxidation states is used to suggest a decreased extent of disproportionation of pentavalent plutonium with increasing temperature over a narrow temperature range. This concept is also used to suggest that the proper selection of sequestering agents, solution acidity and plutonium oxidation number may result in equal concentrations of the four plutonium oxidation states. (auth)

40711 INVESTIGATION OF PLUTONIUM-HALOGEN CHEMISTRY IN ETHYL ACETATE SOLUTION. Bryan, G. H.; Cleveland, J. M.; Sironen, R. J. (Dow Chemical Co., Golden, Colo.). J. Inorg. Nucl. Chem.; 34: No. 6, 2023-8(Jun 1972).

Plutonium may be dissolved in chlorine-saturated ethyl acetate by a mechanism involving chlorination of the solvent to produce chloroethyl acetate and HCl, as well as direct oxidation by chlorine. The resulting solution contains plutonium primarily as the $PuCl_6^{2-}$ anion, with charge balance being provided by protons. Bromine−ethyl acetate also dissolves plutonium, but in this case the mechanism apparently involves only direct oxidation by bromine rather than bromination of the solvent, and the resulting solution contains the trivalent species. Addition of a solution of oxalic acid in ethyl acetate precipitates plutonium oxalate quantitatively from the chlorine solutions and less completely from the bromine solutions. The resulting oxalate may be calcined, fluorinated, and reduced to metal in high yield. (auth)

40712 MOESSBAUER EFFECT STUDIES ON SOME HEPTAVALENT NEPTUNIUM COMPOUNDS. Froehlich, Klaus; Guetlich, Philipp; Keller, Cornelius (Technische Hochschule, Darmstadt, Ger.). J. Chem. Soc., Dalton Trans.; No. 8/9, 971-4(1972).

Four heptavalent neptunium compounds, Li_5NpO_6, $[Co(en)_3]NpO_5.xH_2O$, $Ba_3(NpO_5)_2.xH_2O$, and $Ca_3(NpO_5)_2.xH_2O$ were studied by Mössbauer spectroscopy. The measured isomer shifts of ^{237}Np in these compounds confirm the heptavalent oxidation state of neptunium. Bond properties are inferred from the isomer-shift values on the basis of valence-bond theory. Structural properties of the neptunate(VII) anions are derived from the observed data for the quadrupole splitting and asymmetry parameter. (auth)

40713 ION PAIRING OF Am(III) WITH PERCHLORATE. Baisden, P. A.; Choppin, G. R.; Kinard, W. F. (Florida State Univ., Tallahassee). J. Inorg. Nucl. Chem.; 34: No. 6, 2029-32(Jun 1972).

From solvent extraction data, it is shown that the order of interaction with Am(III) is pTS^- (p-toluenesulphonate) > ClO_4^- > BF_4^-. Corrections of the calculated stability constants for changes in the ionic media indicate that the uncorrected constants are underestimates. These data provide evidence for the formation of $AmClO_4^{2+}$ and $AmpTS^{2+}$ as weak ion-pairs. (auth)

40714 COORDINATION OF URANYL(VI) WITH MONOCARBOXYLATE ANIONS. Magon, L.; Portanova, R.; Zarli, B.; Bismondo, A. (CNR, Padua. Univ., Padua). J. Inorg. Nucl. Chem.; 34: No. 6, 1971-6(Jun 1972).

A quantitative study of the complexing of uranyl(VI) ion by a number of simple monocarboxylate ligands was carried out by a potentiometric method in 1M $(Na)ClO_4$ solution at 20°C. On the basis of the data obtained, in a wide range concentration of the ligands, it is concluded that the UO_2^{2+} ion forms mononuclear successive complexes with a maximum coordination number of 3. Equilibrium constants for the formation of the complexes were determined. (auth)

40715 RECENT ADVANCES IN THE CHEMISTRY OF ORGANOMETALLIC COMPOUNDS OF THE ACTINIDE ELEMENTS. Seaborg, G. T. (Univ. of California, Berkeley). Pure Appl. Chem.; 30: No. 3-4, 539-49(1972).

A brief history of the preparation of organometallic compounds (the tricyclopentadienyls) of the 5f-electronic series, the actinides, is presented. The special micro-techniques employed for the heavier actinides, available for investigation in only microgramme quantities, are described. The compounds of the heavier actinides are characterized by largely ionic bonding. The more recent preparation of cyclooctatetraenyl compounds of the actinides is also described. The uranium(IV) compound is relatively stable, covalent, with a sandwich π-electron structure involving 5f-electrons; since this structure is analogous to ferrocene, the name uranocene has been proposed. These organometallic compounds are relatively volatile and thus sublime at relatively low temperatures. The prospect for preparing organometallic compounds of the heaviest actinides and the transactinides, presently available only on a one-atom-at-a-time basis, is also examined on the basis of inorganic chemistry experiments that have already been performed with such small quantities of these and similar elements. (auth)

40716 AMERICIUM SESQUITELLURIDES. Damien, D.; Charvillat, J. P. (CEN, Fontenay-aux-Roses, France). Inorg. Nucl. Chem. Lett.; 8: No. 8, 705-8(Aug 1972).

In previous work (Damien, 1972) the preparation and the crystallographic characterization of americium tritelluride and ditelluride were described. This communication reports the thermal dissociation studies of $AmTe_2$ leading to the formation of the orthorhombic Am_2Te_3 and at higher temperature, to the formation of the bcc Am_3Te_4. (auth)

40717 SPECTRAL AND MAGNETIC BEHAVIOR OF URANYL (VI) AND CERIUM(III) COMPLEXES OF PICOLINIC ACID. Rastogi, D. K.; Srivastava, A. K.; Jain, P. C.; Agarwal, B. R. Chim. Anal. (Paris); 54: No. 3, 155-8(Mar 1972). (In French).

Uranyl(VI) and cerium(III) were found to form with picolinic acid 1 : 2 and 1 : 3 (metal : ligand) complexes: $[UO_2(C_5H_4NCOO)_2]H_2O$ and $Ce(C_5H_4NCOO)_3$. An anomalous magnetic behavior μeff. = 1.30 B.M. was observed for the uranyl(VI) complex possibly due to temperature-independent paramagnetism. Infrared spectral data reveal essentially ionic oxygen–metal bonding in these complexes. (France)

40718 STUDY OF URANYL SULFATE HYDRATES AND DEUTERATES USING I. R. SPECTROSCOPY. Delobel, Rene; Leroy, Jean-Marie (Ecole Nationale Superieure de Chimie, Lille). Compt. Rend., Ser. C; 274: No. 13, 1286-8(27 Mar 1972). (In French).

The bands due to uranyl and sulfate groups were studied using the ir spectra of uranyl sulfate hydrates. A comparative study of deuterated compounds reveals the existence of water of crystallization. (France)

40719 NEW DETERMINATION OF THE HEAT OF SOLUTION OF AMERICIUM METAL AND THE HEAT OF FORMATION OF VARIOUS AMERICIUM IONS AND COMPOUNDS. Fuger, J. (Univ., Liege); Spirlet, J. C.; Mueller, W. Inorg. Nucl. Chem. Lett.; 8: No. 8, 709-23(Aug 1972).

The heats of solution of americium metal (d.h.c.p. structure) in aqueous hydrochloric acid solutions were measured at 298.15 ± 0.05°K. The values obtained are -616.1 ± 0.8 kJ mol^{-1} in 1M HCl, -615.4 ± 0.8 kJ mol^{-1} in 1.5M HCl and -613.1 ± 1.4 kJ mol^{-1} in 6M HCl. From these data, the standard enthalpy of formation of $Am^{3+}(aq)$ is obtained as -616.7 ± 1.2 kJ mol^{-1} and the standard potential of the Am(0)/Am(III) couple is calculated to be 2.06 ± 0.01 V. New values for the heat of formation of various americium ions and compounds are presented. (auth)

Radioactive Waste Treatment

Refer also to abstracts 41485, 41487, and 42477.

40720 (KFK-1553) SEPARATION OF AMERICIUM AND CURIUM FROM HIGHLY RADIOACTIVE WASTE SOLUTIONS. PART I. LABORATORY BATCH STUDIES. Kolarik, Z.; Koch, G.; Kuesel, H. H.; Fritsch, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Feb 1972. 35p. Dep. NTIS (U. S. Sales Only).

Optimum conditions of a solvent extraction process for isolation of Am and Cm from highly radioactive wastes were sought. Highly extractable multivalent fission and corrosion products can be separated as precipitates in decomposition of nitric acid by reduction with formic acid. Am and Cm can then be extracted together with fission lanthanides(III) by a solution of bis(2-ethylhexyl) phosphate and tributyl phosphate in an alkane solvent and separated from the lanthanides(III) by a selective back extraction with an aqueous solution of diethylenetriaminepentaacetic and lactic acids. The spent organic phase can be recovered by washing with a 2 to 5M nitric acid solution and, subsequently, a sodium lactate and sodium hydroxide solution. (auth)

40721 NOBLE GAS ADSORPTION CHARACTERISTICS OF CHARCOAL BEDS: VAN DEEMTER'S COEFFICIENTS EVALUATION. Curzio, G. G.; Gentili, A. F. (Univ., Pisa, Italy). Anal. Chem.; 44: No. 8, 1544-5(Jul 1972).

The use of Van Deemter's equation in the study and design of filters for fission-produced radioactive noble gas retention in nuclear plants was explored. The behavior of a charcoal bed was investigated by the analysis of the broadening of a krypton (traced with radioactive ^{85}Kr) pulse injected into the beds. Experimental results suggest a dependence of h (reduced height) on the temperature at constant v_i (reduced interparticle velocity). The experimental points were fitted tentatively by Van Deemter's equation with a temperature dependence of the diffusion coefficient different from the usually adopted form. (D.H.M.)

40722 SOLIDIFYING TESTS OF HIGHLY ACTIVE FISSION PRODUCT SOLUTIONS. Guber, W.; Hild, W. pp 606-8 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

An account is given of the development and testing of a procedure for solidification of highly active fluid wastes, which are to be expected from the Karlsruhe fuel reprocessing plant. The research work comprises basic laboratory investigations (concerning, for instance, glass melting, physicochemical properties of glasses: fission product oxides, melting point, wash-out rates, reduction of activity losses due to evaporation processes, off-gas purification), construction of complete glass-melting equipment on a laboratory scale according to the semicontinuous in-pot melting method, and development of a pilot plant for continuous solidification of fluid fission product solutions. The laboratory equipment is composed of a denitrating device, a melting and a tempering furnace, and an off-gas purification device. The pilot plant comprises a continuously operating denitrating part and a spray calciner, as well as an induction-heated melting pot. (INIS)

40723 PROCESSING AND DISPOSAL OF LOW AND INTERMEDIATE LEVEL WASTES IN THE NUCLEAR RESEARCH CENTER KARLSRUHE. Diefenbacher, W.; Baehr, W. pp 609-12 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The processing of the various radioactive wastes accruing in the Nuclear Research Center Karlsruhe (waste water, organic solvents, solid wastes), methods of concentration and solidification, and, finally, transport and storage in the salt mine Asse II are described. (INIS)

Radioisotope Production

Refer also to abstract 40627.

40724 (ORNL-4767) TRANSURANIUM PROCESSING PLANT. Semiannual Report of Production, Status, and Plans for Period Ending December 31, 1971. Burch, W. D.; Bigelow, J. E.; King, L. J. (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 37p. Dep. NTIS.

During the period of July 1, 1971, through December 31, 1971, 10 g of ^{242}Pu, 181 g of ^{244}Cm, 26 mg of ^{249}Bk, 210 mg of ^{252}Cf, and 38 μg of ^{253}Es were recovered as purified products from nine reactor tubes that had been irradiated as part of the Californium-I program at the Savannah River Plant (SRP) to evaluate the commercial market for ^{252}Cf and to establish an inventory of ^{252}Cf for sale. It was determined that, by irradiating curium from the Californium-I program in the HFIR, all of the ^{252}Cf that would be required to meet the postulated demands (from 0.5 g/year in 1972 up to 1.8 g/year in 1980) of both the Research and the Production Divisions could be produced. Alternatively, by irradiating only curium that resulted from the Curium-II campaign at Savannah River, production would be limited to a steady-state production rate of 0.5 g/year. The processes and equipment used to process the SRP Pu–Al tubes were generally the same as those used to process HFIR targets and the SRP slugs. However, an 11-ft-long dissolver was required to dissolve the 5-ft-4-in.-long sections of SRP tubes, and a different procedure was used to dissolve the aluminum from the tubes. A technique was developed for producing uniform particles of curium oxide in the desired size range for use in fabricating HFIR targets. The curium is sorbed on Dowex-50 resin, which is then calcined to convert the curium to the oxide form. Six targets, which were fabricated from oxide produced by this technique, are being irradiated in the HFIR. Nineteen neutron sources were fabricated during this period, bringing the total fabricated to date to 49. In special projects, (1) a special target was removed from the HFIR and was cut up to recover the components for various experimental purposes, (2) two additional gamma sources were fabricated (one each from 500 mg of ^{240}Pu and 500 mg of ^{238}Pu) for use in Moessbauer studies, and (3) a rabbit containing 250 μg of ^{240}Pu was fabricated, irradiated, and shipped to LBL. The values currently being used for transuranium-element decay data and for cross-section data in planning irradiation-processing cycles, calculating production forecasts, and assaying products are tabulated in the Appendix. (auth)

Reactor Fuel Reprocessing

40725 (DOCKET-50201-122) WEST VALLEY REPROCESSING PLANT. Approval Requested to Continue under Interim Specifications on Liquid Effluents until December 31, 1972. (Nuclear Fuel Services, Inc., Rockville, Md.). 14 Jun 1972. 10p. Dep. NTIS.

Information is presented in support of request for continued operation of the low-level waste-treatment facility under the interim specifications on liquid effluents until December 31, 1972. Topics covered include: coagulant rate, sludge level, clay addition, chelating agents, phosphate removal, resin selection, elution procedure, resin characterization, clinoptilolite addition, polishing bed, distribution characteristics, ruthenium removal, and treatment of laundry effluent. (M.C.G.)

40726 (DOCKET-50201-123) WEST VALLEY REPROCESSING PLANT. Low Level Liquid Waste Treatment Facility, Summary Report No. 7. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 20 Jun 1972. 26p. Dep. NTIS.

The latest plant performance and the current revised status of the development program are summarized. Removal factors are presented for ^{137}Cs, ^{90}Sr, ^{106}RuRh, and gross β. Difficulties in ion exchanger regeneration were eliminated by making modifications to the regeneration procedure. (M.C.G.)

40727 (DOCKET-50332-26) BARNWELL NUCLEAR FUEL PLANT. Seismic Analysis Methods for Piping Systems. (Allied-Gulf Nuclear Services, Barnwell, S. C.). 19 Jun 1972. 5p. Dep. NTIS.

The dynamic analysis method is based on the spectrum response technique. Its use is limited to critical large piping systems only. The simplified analysis method is simpler to use, but requires more guiding and supporting of a piping system. It is used for analyzing most of the piping systems. (M.C.G.)

40728 (INR-P-1362) SPECIFIC ENGINEERING AND TECHNOLOGICAL PROBLEMS OF PROCESSING REACTOR FUELS OF HIGH BURNUP BY WET METHODS. Hoffmann, Przemyslaw M. (Institute of Nuclear Research, Warsaw (Poland)). 1971. 9p. (CONF-700540-8). Dep. NTIS (U. S. Sales Only).

From Polish-Italian seminar on some chemical, ceramic, and metallurgical aspects of nuclear fuels; Zakopane, Poland (29 May 1970).

Radiochemical and technological difficulties of processing spent fuels of high burnup by wet methods are discussed. These difficulties result from a high specific activity of fuel solutions, and from a risk of criticality in case of highly enriched uranium fuels or plutonium. The possibility of adapting the Purex method to process such fuels is discussed. Studies on engineering, apparatus, and technological aspects aiming at intensification of the method are discussed. (auth)

40729 (IS-T-525) DYNAMIC STUDY OF THE EXTRACTION OF RARE EARTH CHLORIDE-D2EHPA-HCl IN A MULTISTAGE MIXER-SETTLER EXTRACTOR. Beetner, Gary Arnold (Ames Lab., Iowa). May 1972. Contract W-7405-eng-82. 88p. Dep. NTIS.

Thesis.

The flow patterns within a pump mix mixer-settler extractor were studied photographically and visually. Dye was injected into the pump mixer and followed through the various portions of the equipment. These results were analyzed to give both a quantitative and qualitative measure of the flow within a single stage. A mass transfer mechanism was derived based on a pseudo distribution constant and a pseudo first order rate constant. These constants were adjusted to give both the proper output concentrations, and stagewise concentrations of the proper form. The results of both these studies were programmed on an IBM 360 model 65 digital computer. The results obtained by this computer simulation of startup to steady state were compared to experimental data. The comparison showed very close agreement. A second simulation was then constructed and run to demonstrate that the model could be greatly simplified, and good results still obtained. (auth)

40730 (ORNL-4436(Suppl.1)) AQUEOUS PROCESSING OF LMFBR FUELS: TECHNICAL ASSESSMENT AND EXPERIMENTAL PROGRAM DEFINITION. Sections 4.4 and 5.4. Goode, J. H.; Clinton, S. D. (comp. and ed.) (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 47p. Dep. NTIS.

A revision of Sections 4.4 and 5.4 of ORNL-4436 is presented, which incorporates summaries of work completed since the issuance of the original document in June 1970 up to about October 1971. Voloxidation to volatilize and remove tritium, iodine, xenon, and krypton from the sheared fuel and blanket materials for trapping and ultimate storage as wastes is discussed. Fabrication and irradiation parameters affecting voloxidation and experimental results with irradiated and unirradiated fuels are considered. (M.C.G.)

40731 (ORNL-TM-2585) AQUEOUS PROCESSING OF LMFBR FUELS. Progress Report No. 2, April 1969. Unger, W. E.; Blanco, R. E.; Watson, C. D.; Crouse, D. J.; Irvine, A. R. (comps. (Oak Ridge National Lab., Tenn.). May 1969. Contract W-7405-eng-26. 37p. Dep. NTIS.

Progress in the development of aqueous methods for the reprocessing of LMFBR fuels is outlined. Development work is reported on problems of irradiated fuel transport to the processing facility, the dissolution of the fuel and the chemical recovery of the PuO_2-UO_2 values, the containment of volatile fission products, and product purification for subsequent reconstitution into reactor fuel. Pertinent experimental results are presented for the information of those immediately concerned with the field. Detailed description of experimental work and data are included in topical reports and in the Chemical Technology Division Annual Report. (auth)

40732 (ORNL-TM-2624) AQUEOUS PROCESSING OF LMFBR FUELS. Progress Report No. 3, May 1969. Unger, W. E.; Blanco. R. E.; Watson, C. D.; Crouse, D. J.; Irvine, A. R. (comps.) (Oak Ridge National Lab., Tenn.). Jun 1969. Contract W-7405-eng-26. 41p. Dep. NTIS.

FISSION PRODUCTS—volatilization from oxide fuels
IODINE—volatilization in oxide fuel dissolution in nitric acid
  —separation from gas streams by scrubbing with mercury nitrate solutions
  —separation from gas streams by sorption on iodized charcoal
LIQUID METAL FAST BREEDER REACTOR—fuel reprocessing for, research progress (May, 1969) on aqueous
MERCURY NITRATES—reactions with methyl iodide
METHANE, IODO-—reactions with mercury nitrate solutions
PHOSPHONIC ACID, TRIBUTYL ESTER—decomposition of, chromatographic studies on
PUREX PROCESS—flowsheet development for LMFBR fuels
REACTOR FUEL ELEMENTS—reprocessing of LMFBR, single pin shearing or melt decladding in head-end
REACTOR FUELS—reprocessing of LMFBR, research progress (May, 1969) on aqueous
  —shipping spent oxide, evaluation of mercury and water as coolants in casks for
ZIRCONIUM—precipitation by TBP degradation products (M.C.G.)

40733 (ORNL-TM-2650) AQUEOUS PROCESSING OF LMFBR FUELS. Progress Report No. 4, June 1969. Unger, W. E.; Blanco, R. E.; Watson, C. D.; Crouse, D. J.; Irvine, A. R. (comps.) (Oak Ridge National Lab., Tenn.). Jul 1969. Contract W-7405-eng-26. 47p. Dep. NTIS.

FISSION PRODUCTS—volatilization from carbide fuel
IODINE—separation from fuel reprocessing off gases
LIQUID METAL FAST BREEDER REACTOR—fuel reprocessing for, research progress (June, 1969) on aqueous
MERCURY NITRATES—reactions with methyl iodide
METHANE, IODO-—reactions with mercury nitrate
PLUTONIUM—separation from oxide fuel by solvent extraction using TBP
PLUTONIUM CARBIDES—PuC-UC, dissolution in nitric acid
PUREX PROCESS—flowsheet development for LMFBR fuels
REACTOR FUEL ELEMENTS—shipping of, temperature profile in mercury-filled cask for
  —reprocessing of LMFBR, temperature-time history for head-end
  —reprocessing of stainless steel-clad oxide, rotary shear or melt process for head-end
REACTOR FUELS—reprocessing of LMFBR, research progress (June, 1969) in development of aqueous methods for
  —shielding of spent LMFBR
URANIUM—separation from oxide fuel by solvent extraction using TBP
URANIUM CARBIDES—PuC-UC, dissolution in nitric acid (M.C.G.)

40734 (ORNL-TM-2671) LMFBR FUEL CYCLE STUDIES PROGRESS REPORT NO. 5. (Oak Ridge National Lab., Tenn.). Aug 1969. Contract W-7405-eng-26. 99p. Dep. NTIS.

IODINE—separation from off gases from fuel reprocessing
LIQUID METAL FAST BREEDER REACTOR—fuel cycle development studies (August, 1969) for
MERCURY NITRATES—reactions with methyl iodide
METHANE, IODO—reactions with mercury nitrate
PLUTONIUM CARBIDES—PuC-UC, dissolution in nitric acid
PLUTONIUM NITRATES—conversion to oxides in sol-gel process
PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, preparation from nitrate solutions by sol-gel process
  —PuO_2-UO_2, fabrication of, obtained from sol-gel process
  —PuO_2-UO_2, burnup studies on
REACTOR FUEL ELEMENTS—shipping of spent LMFBR, heat dissipation tests on casks for
  —reprocessing of stainless steel-clad oxide, design of multipin shear and melt decladding studies for head-end
REACTOR FUELS—reprocessing of LMFBR, research progress (August, 1969) on aqueous
URANIUM CARBIDES—PuC-UC, dissolution in nitric acid
URANIUM NITRATES—conversion to oxides in sol-gel process
URANIUM OXIDES UO_2—PuO_2-UO_2, preparation from nitrate solutions by sol-gel process
  —PuO_2-UO_2, fabrication of, obtained from sol-gel process
  —PUO_2-UO_2, burnup studies on
ZIRCONIUM—precipitation with TBP degradation products (M.C.G.)

40735 (ORNL-TM-2710) LMFBR FUEL CYCLE STUDIES PROGRESS REPORT FOR AUGUST, NO. 6. (Oak Ridge National Lab., Tenn.). Oct 1969. Contract W-7405-eng-26. 73p. Dep. NTIS.

FISSION PRODUCTS—volatilization from oxide fuels
IODINE—separation from fuel reprocessing effluents
LIQUID METAL FAST BREEDER REACTOR—fuel cycle development studies (August, 1969) for
MERCURY NITRATES—reactions with methyl iodide
METHANE, IODO—sorption on silver zeolite
—reactions with mercury nitrates
PLUTONIUM—purification in Purex Process
PLUTONIUM OXIDES—PuO_2-UO_2, fabrication of pellets of, in LMFBR fuel recycle program
PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, preparation of powders of, from solutions from fuel reprocessing cycle
—PuO_2-UO_2, preparation by sol-gel process
REACTOR FUEL ELEMENTS—shipping of spent LMFBR, cask evaluation for
—reprocessing of stainless steel clad oxide, head-end processes in
—shielding requirements for spent LMFBR
REACTOR FUELS—reprocessing of LMFBR, research progress (August, 1969) on
—performance evaluation of oxide
URANIUM OXIDES UO_2—PuO_2-UO_2, preparation of powders of, from solutions from fuel reprocessing cycle
—PuO_2-UO_2, preparation by sol-gel process
—PuO_2-UO_2, fabrication of pellets of, in LMFBR fuel recycle program (M.C.G.)

40736 (ORNL-TM-2748) LMFBR FUEL CYCLE STUDIES PROGRESS REPORT FOR SEPTEMBER, NO. 7. (Oak Ridge National Lab., Tenn.). Nov 1969. Contract W-7405-eng-26. 95p. Dep. NTIS.

IODINE—separation from reactor fuel reprocessing effluents
LIQUID METAL FAST BREEDER REACTOR—fuel cycle development studies (Sept., 1969) for
PLUTONIUM CARBIDES—PuC-UC, preparation by sol-gel process
PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, preparation of powders of, from fuel reprocessing solutions
—PuO_2-UO_2, preparation from nitrate solutions by sol-gel process
—PuO_2-UO_2, fabrication of pellets of, from materials from sol-gel process
PUREX PROCESS—developments in, for LMFBR fuels
REACTOR FUEL ELEMENTS—shipping of spent LMFBR, Cask tests for
—reprocessing of stainless steel-clad oxide, dismantling, shearing, and melting processes for head-end
—shielding requirements for LMFBR
REACTOR FUELS—reprocessing of LMFBR, research progress (Sept., 1969) on aqueous
—performance of oxide
URANIUM CARBIDES—PuC-UC, preparation by sol-gel process
URANIUM OXIDES UO_2—PuO_2-UO_2, preparation of powders of, from fuel reprocessing solutions
—PuO_2-UO_2, preparation from nitrate solutions by sol-gel process
—PuO_2-UO_2, fabrication of pellets of, from materials from sol-gel process (M.C.G.)

40737 (ORNL-TM-2764) LMFBR FUEL CYCLE STUDIES PROGRESS REPORT FOR OCTOBER, NO. 8. (Oak Ridge National Lab., Tenn.). Nov 1969. Contract W-7405-eng-26. 101p. Dep. NTIS.

IODINE—volatilization of fission product, from oxide fuels
—separation from fuel reprocessing effluents
LIQUID METAL FAST BREEDER REACTOR—fuel cycle development studies (October, 1969) for
PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, preparation from nitrates from fuel reprocessing cycle
—PuO_2-UO_2, preparation by sol-gel process
—PuO_2-UO_2, fabrication of pellets of, from so-gel-derived powders
RARE GASES—volatilization of fission product, from oxide fuels
REACTOR FUEL ELEMENTS—shipping of spent LMFBR, evaluation of casks for
—reprocessing of stainless steel-clad oxide, dismantling, heat dissipation, and shearing for head-end
—shipping of spent LMFBR, criticality calculations for
REACTOR FUELS—reprocessing of LMFBR, research progress (October, 1969) on aqueous
—performance evaluation of oxide
URANIUM NITRIDES—dissolution in nitric acid
URANIUM OXIDES UO_2—PuO_2-UO_2, preparation from nitrates from fuel reprocessing cycle
—PuO_2-UO_2, preparation by sol-gel process
—PuO_2-UO_2, fabrication of pellets of, from sol-gel-derived powders (M.C.G.)

40738 (ORNL-TM-2795) LMFBR FUEL CYCLE STUDIES PROGRESS REPORT FOR NOVEMBER 1969, NO. 9. (Oak Ridge National Lab., Tenn.). Dec 1969. Contract W-7405-eng-26. 84p. Dep. NTIS.

IODINE—separation from fuel reprocessing effluents
LIQUID METAL FAST BREEDER REACTOR—fuel cycle development studies (Nov., 1969) for
PHOSPHORIC ACID, TRIBUTYL ESTER-—radiation stability
PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, preparation from nitrates from fuel recycle program by sol-gel process
—PuO_2-UO_2, preparation of pellets of, from sol-gel process powders
PUREX PROCESS—flowsheet modifications for LMFBR fuels
REACTOR FUEL ELEMENTS—shipping of spent oxide, cask evaluation studies for
REACTOR FUELS—reprocessing of LMFBR, research progress (Nov., 1969) on aqueous
—radioactivity and isotopic composition of spent LMFBR
—performance of
TRITIUM—volatilization from oxide fuels
URANIUM OXIDES UO_2—PuO_2-UO_2, preparation from nitrates from fuel recycle program by sol-gel process
—PuO_2-UO_2, preparation of pellets of, from sol-gel process powders (M.C.G.)

40739 (ORNL-TM-2819) LMFBR FUEL CYCLE STUDIES PROGRESS REPORT FOR DECEMBER 1969, NO. 10. (Oak Ridge National Lab., Tenn.). Jan 1970. Contract W-7405-eng-26. 76p. Dep. NTIS.

IODINE—separation from gases released in fuel reprocessing
LIQUID METAL FAST BREEDER REACTOR—fuel cycle development studies (Dec., 1969) for
PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, preparation of powders and spheres of, from nitrate solutions from fuel reprocessing cycle
—PuO_2-UO_2, preparation by sol-gel process
—PuO_2-UO_2, fabrication of pellets of, from sol-gel-derived materials
—PuO_2-UO_2, irradiation testing of fuels of
PUREX PROCESS—flowsheet modification for LMFBR fuels
—solvent stability in
REACTOR FUEL ELEMENTS—shipping of spent oxide
—reprocessing of stainless steel-clad oxide, head-end processes in
—criticality studies on spent LMFBR
REACTOR FUELS—reprocessing of LMFBR, research progress (Dec., 1969) on aqueous
URANIUM OXIDES UO_2—PuO_2-UO_2, preparation of powders and spheres of, from nitrate solutions from fuel reprocessing cycle
—PuO_2-UO_2, preparation by sol-gel process
—PuO_2-UO_2, fabrication of pellets of, from sol-gel-derived materials
—PuO_2-UO_2, irradiation testing of fuels of (M.C.G.)

40740 PROCESS FOR CONTINUOUS SELECTIVE CONCENTRATION AND SEPARATION OF IONS IN AQUEOUS SOLUTIONS BY MEANS OF AN ION SELECTIVE MEMBRANE. Wallace, R. M. (to United States Atomic Energy Commission). Norwegian Patent 168,759. 26 Jun 1967. Priority date 10 Aug 1966, United States. (In Norwegian).

The ions in an aqueous solution are selectively concentrated and separated in a continuous process. The primary solution, containing the ions to be concentrated, is brought in contact with an ion-selective membrane with polar-selective permeability while a secondary solution containing another ion type with the same polarity as the first is in contact with the other side of the membrane. The composition of both solutions is controlled so that the chemical potential difference between the ion types is maintained. The solutions are kept in contact with the membrane long enough to allow a significant amount of the first and some of the second ions to diffuse through the membrane, whereby the first ions are concentrated in the secondary solution. By introducing into the secondary solution a material that forms a complex with the first ions, these may be continuously removed from the secondary solution. This process gives an improved selectivity and allows better control than with conventional dialysis or electrodialysis and is especially suitable for the concentration of uranyl and strontium ions from solutions in the reprocessing of nuclear fuel. (Norway)

40741 MIDWEST REPROCESSING PLANT. Nucl. Eng. Int.: 17: No. 193, 481-2(Jun 1972).

The Midwest reprocessing plant has a nominal capacity for handling about 1 te/day of irradiated fuel. Brief descriptions are given of the site, the plant, processing operations, process control, and waste handling. (UK)

40742 DEVELOPMENT OF IN-LINE INSTRUMENTS FOR THE CONTROL OF PROCESSES IN REPROCESSING PLANTS. Baumgaertel, G.; Kuhn, E.; Ertel, D. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). pp 602-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

With regard to a continuous process in reprocessing plants, the use of automatic analyzing instruments, directly connected to the process current, is highly desirable, as they offer the possibility of continuously controlling the process, and as they are indispensable for a computer-controlled process automation. An account is given of the development of some useful inline devices for the Purex process, followed by a description of three in-line methods developed to prototype stage: simultaneous measurement of density and conductivity; nondispersive x-ray fluorescence; and polarography. (INIS)

40743 SUPER-SHIELDED MINIATURE-EXTRACTION INSTALLATION MILLI IN THE INSTITUTE FOR HOT CHEMISTRY OF THE GESELLSCHAFT FUER KERNFORSCHUNG KARLSRUHE. Leichsenring, C. H.; Ochsenfeld, W.; Diefenbacher, W.; Meier, G. (Kernforschungszentrum, Karlsruhe, Ger.). pp 682-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The concept of the miniature extraction plant MILLI, which serves to reprocess irradiated U/Pu-mixed oxide fuels and uses a modified Purex process is described. Improvements of the installation have been accomplished recently to allow its being used for the recovery of americium and curium. (INIS)

40744 PLANS FOR A SEMI-TECHNICAL PILOT PLANT FOR THE REPROCESSING OF HTGR FUEL ELEMENTS. Kaiser, G.; Sckuhr, P.; Witte, H. (Kernforschungsanlage, Juelich, Ger.). pp 686-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Plans are outlined for a semi-technical pilot plant for the reprocessing of HTGR fuel elements to be erected by the Nuclear Research Center Juelich; the project is called Jupiter. A description of the planned plant is followed by a survey of the present state of the project. (INIS)

40745 COLD PILOT PLANT FOR THE COMBUSTION OF GRAPHITE AS HEAD END IN THE REPROCESSING OF HTR FUEL ELEMENTS. Pirk, H.; Tillessen, U. (Nuklear-Chemie und -Metallurgie GmbH, Wolfgang, Ger.). pp 690-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

An earlier idea to burn the graphite of HTR fuel elements for their reprocessing during the initial stage of this process, i.e., the head-end, in a shaft furnace was reconsidered with regard to the reprocessing of spherical fuel elements. The problems encountered during planning and experiments for an extension of the furnace procedure to an engineering-scale are discussed, with the considerations proceeding from the one-sphere model up to the cold pilot plant design. (INIS)

40746 EXPERIENCE WITH THE DECONTAMINATION OF PARTS OF THE EUROCHEMIC PLANT AFTER FOUR YEARS OF ACTIVE OPERATION. Heinz, W.; Centeno, J.; Van Geel, J. (Eurochemic, Mol, Belg.). pp 694-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

In the course of a general rebuilding of parts of the Eurochemic plant, including the new construction of three additional extraction cycles, Eurochemic has carried out an extensive decontamination program, which involved the installation of nine hot cells. The decontamination process is outlined, together with a comparison of the efficiency of various decontaminating agents. (INIS)

40747 BEHAVIOR OF PLUTONIUM AND URANIUM IN THE WAK FLOW SHEET. Ochsenfeld, W. (Kernforschungszentrum, Karlsruhe, Ger.). pp 698-701 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The behavior of plutonium and uranium in the first and second extraction cycles of the Karlsruhe reprocessing plant (WAK) was studied. The extraction of fuels containing 1% plutonium was investigated using 30% TBP–alkane. Mixer-settlers of the CEN type are used on a laboratory scale, with several steps having a separation efficiency of 80 to 90%, and with the solutions remaining in the various chambers for periods equal to those applied under real technical WAK plant conditions. Theoretically calculated numbers of steps for the achievement of a 99.9% recovery of uranium and plutonium are compared to the number of steps actually needed in the laboratory experiment to obtain the same percentage. The number of chambers used during laboratory experiments is compared to the number of chambers existing in the WAK plant. (INIS)

40748 USE OF PLUTONIUM-CONTAINING FUELS AND RESULTING CONSEQUENCES ON THE CHEMISTRY AND TECHNOLOGY OF FUEL REPROCESSING. Knoch, W. (Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen mbH, Leopoldshafen, Ger.); Ochsenfeld, W.; Baumgaertel, G. pp 702-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Investigations were carried out as to technical and economic consequences of higher plutonium contents (>0.6%) on the reprocessing of plutonium-containing fuels. Taking the Karlsruhe reprocessing plant (WAK) as an example, such problems are outlined as arise in connection with the recycling of fuels to thermal reactors, discussing particularly investigations on criticality, chemical flowsheet, final plutonium purification, and concentration of the endproduct. The results were evaluated and interpreted with regard to breeder reactor fuels. (INIS)

40749 DEVELOPMENT OF A MIXER-SETTLER FOR THE ELECTROLYTIC PLUTONIUM–URANIUM SEPARATION IN THE PUREX PROCESS. Schmieder, H.; Baumgaertner, F.; Goldacker, H.; Hausberger, H. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). pp 706-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The main reason for the development of a multistep mixer–settler for the electrolytic separation of plutonium and uranium on a technical scale was the aim to achieve a reduction of Pu(IV) to the nonextractable Pu(III) without having to add reducing chemical agents. Extensive research work was carried out in order to find appropriate cathode, anode, and structural material, and on platinum as suitable anode material. It is possible to achieve with a 16-step electrolysis mixer-settler decontamination factors for the plutonium–uranium separation that at least equal those obtained by adding reductants. (INIS)

40750 RESULTS OF AQUEOUS REPROCESSING METHODS FOR THORIUM-ENRICHED NUCLEAR FUELS WITH HIGH BURNUP. Schaefer, L. (Farbwerke Hoechst AG, Frankfurt am Main); Wojtech, B.; Brodda, B. G.; Kirchner, H.; Riedel, H. J. pp 710-13 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Results of extraction studies are given that used nitric feed solutions instead of solutions with a deficiency of nitric acid. It appeared that this prevents the deposition of inconvenient hydrolysis precipitations. Interium-23 and Thorex processes with acid feed solution are described, followed by a comparison of results thus obtained with those obtained from experiments with a deficiency of nitric acid. (INIS)

ENGINEERING

40751 COMPARISON OF ELASTICITY AND SHELL-THEORY SOLUTIONS FOR FINITE CIRCULAR CYLINDRICAL SHELLS. Iyengar Sundara Raja, K. T. (Indian Inst. of Science, Bangalore); Sebastian, V. K. Nucl. Eng. Des.; 21: No. 1, 137-57 (1972).

A finite circular cylindrical shell subjected to a band of uniform pressure on its outer rim was investigated, using three-dimensional elasticity theory and the classical shell theories of Timoshenko (or Donnell) and Flügge. Detailed comparison of the resulting stresses and displacements was carried out for shells with ratios of inner to outer shell radii equal to 0.80, 0.85, 0.90, and 0.93 and for ratios of outer shell diameter to length of the shell equal to 0.5, 1 and 2. The ratio of band width to length of the shell was 0.2 and Poisson's ratio used was equal to 0.3. An Elliot 803 digital computer was used for numerical computations. (auth)

Energy Conversion

40752 (RT/ING-(71)20) STATUS OF THE RESEARCH ON CLOSED CYCLE MHD POWER GENERATION. Bertolini, E.; Toschi, R.; Zampaglione, V. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 17 Dec 1971. 39p. Dep. NTIS (U. S. Sales Only).

A complete survey of the status of the research and of the potentialities of the nuclear MHD system to convert heat into electricity is presented. The Direct Energy Conversion Laboratory of CNEN at Frascati is presently engaged in this field of research. The results reported at the recent international symposium held in Munich, both in experiments and theories concerning the MHD generator and the studies on high-temperature nuclear reactors, allow overall plant efficiencies higher than 50% to be realized. The most significant results in system analysis studies and in the power generation experiments are presented. A critical analysis is made concerning the main mechanisms, still under study, which are responsible for reductions in the generator performances when compared with the ideal behavior and the scaling laws used so far to extrapolate the present size experimental results for power plant of 1.000 MW(t) or even more. (auth)

40753 (UCRL-73555(Rev.1)) TRITIUM BREEDING AND DIRECT ENERGY CONVERSION. Lee, Joseph D. (California Univ., Livermore. Lawrence Livermore Lab.). 12 May 1972. 41p. (CONF-720402-1). Dep. NTIS.

From one-hundred-sixty-third national meeting of American Chemical Society; Boston, MA. (9 Apr 1972).

Tritium breeding and direct energy conversion are key technological problems in the development of practical fusion reactors. Lithium in some form is needed for tritium generation, but certain chemical problems must be overcome. Alternatives to lithium metal should be considered. Better methods must be developed for efficiently recovering the tritium and safely disposing of the unwanted byproducts. Separation of the fusion fuel and waste products will be especially challenging for mirror machines with direct energy conversion. Hopefully, in the long run, these machines will employ the ^{3}He fuel cycle, but this will impose additional demands for efficient helium isotope separation and, possibly, tritium storage in some manner that allows for recovery of the ^{3}He decay product. (auth)

40754 SPECTROSCOPIC DETERMINATION OF PLASMA TEMPERATURE IN A LOW-POWER MHD GENERATOR. Ionescu-Bujor, Th.; Ionescu, G.; Katona, L. (Inst. of Physics, Bucharest). Stud. Cercet. Fiz.; 24: No. 4, 515-20(1972). (In Rumanian).

Results are presented concerning the temperature of $Ar-N_2$ plasma seeded with 1% mixture of K and Na. The temperature was measured at the exit of the mixing chamber and inside the channel of the 40 kW(t) MHD generator, and its dependence on the parameters of interest for the performance of the generator was investigated. The modified D-line reversal method was found to be useful for the studies. (auth)

40755 MAGNETOHYDRODYNAMIC ENERGY CONVERSION. Blom, J. H.; Houben, J. W. M. A.; Rietjens, L. H. Th. (Technische Hogeschool, Eindhoven, Netherlands). Ned. Tijdschr. Natuurk.; 38: No. 2, 21-31(20 Jan 1972). (In Dutch).

An MHD generator for use in an energy conversion installation was subjected to an approximate analysis. The principle of the generator was outlined and the physical bases were given. The specific generator characteristics of non-equilibrium ionization, relaxation effects, instabilities, current distribution, and boundary layers were considered. Canal geometries were described. (J.S.R.)

40756 STUDY OF WINDINGS USED FOR ALTERNATING CURRENT MAGNETOHYDRODYNAMIC PUMPS AND MOBILE FIELD LINEAR MOTORS. Barth, Hans (Univ., Brasov, Rumania). Electrotehnica (Bucharest); 20: No. 3, 106-10(Mar 1972). (In Rumanian).

A type of winding is described which is used for MHD alternating current pumps and mobile field linear motors. The winding helps in elimination of the alternating (pulsatory) magnetic field in the air gap between the two linear plane inductors, and helps achieve maximum electromagnetic force and maximum efficiency. The study includes theoretical demonstrations, phenomenologic explanations as well as experimental comparative data. (auth)

40757 OUTLOOK FOR ENERGY IN THE UNITED STATES TO 1985. Winger, John G.; Emerson, John D.; Gunning, Gerald D.; Sparling, Richard C.; Zraly, Arthur J. New York; Chase Manhattan Bank (1972). 56p.

The outlook for energy production and consumption in the U. S. to 1985 is discussed in terms of: the significance of energy supplies; sources of energy; projected energy demands based on population growth and age distribution in the population; the primary markets which include transportation, industrial, commercial, residential, and electric utilities; uses of energy in specified geographical regions; and overall U. S. supply and demand for natural gas, petroleum, coal, nuclear fuels, and water power. It is concluded that: none of the five domestic sources of primary energy is now adequate to meet the nation's needs; the energy shortage will become greater for a period of time; curbing consumption is not a practical solution; and a lasting solution will require a greater expenditure of capital to develop energy and consequently a higher cost to consumers. Greater government intervention is needed to provide both the capital funds for developing energy resources and realistic regulations so that the nation can achieve environmental gains without sacrificing its supply of energy. (L.C.L.)

40758 MAIN TECHNICAL TRENDS IN THERMAL POWER ENGINEERING. Troitskii, A. A.; Alekseev, I. A.; Iodidio, E. A. Therm. Eng. (USSR) (Engl. Transl.); 18: No. 4, 5-9(1971).

Translated from Teploenergetika; 18: No. 4, 4-6(1971).

Development of power supplies in the Soviet Union is reviewed. It is noted that after 1980 combined cycles will be used incorporating high-capacity magnetohydrodynamic generators as high-temperature topping units in combination with steam power plants operating on fossil or nuclear fuel. The efficiency of such plants is expected to be about 50 to 55%. (J.R.D.)

40759 ENERGY NEEDS AND GROSS NATIONAL PRODUCT: THE CASE OF ITALY. Silvestri, M. (CISE, Milan). Energ. Nucl. (Milan); 19: No. 6, 371-9(Jun 1972). (In Italian).

A practical method for reliably determining the relation between energy needs and development of an economic system has been proposed by Brookes, Economic Planning Department, UKAEA. This method is applied, suitably modified, to the Italian industrial development along its whole history, assuming the year 1881 as its beginning and extrapolating to the year 2000. In this way the conclusion is drawn that the Brookes method is likely not only to interpret the past with reasonable accuracy, but also allows better forecasting of future needs than the methods currently used. (auth)

40760 LOW RADIATION NUCLEAR PACEMAKER BATTERY. Gatt, F. C. (Australian National Heart Foundation, Sutherland). Aust. Phys.; 9: No. 3, 37-9(Mar 1972).

The design and preliminary results of an experimental nuclear cardiac pacemaker battery are described. Expected electrical output is 200 microwatts at 5 volts. The radioisotope considered is tritium, a pure beta emitter, with a very low beta energy. The radiation energy is converted to electrical energy via the electron voltaic effect. Calculated radiation characteristics are given and compared with existing overseas nuclear battery characteristics. Toxicity of the isotope is also compared with that of nuclides used elsewhere for similar purposes. Gas generation in the battery is described and a method to contain the gas is discussed. A short resumé of work done overseas is included. (auth) (Australia)

40761 THERMALLY CASCADED THERMOELECTRIC GENERATOR. Paine, T. O. U. S. Patent 3,666,566. 30 May 1972. Filed 24 Jul 1969.

A thermally cascaded thermoelectric generator is described. The generator includes a first stage containing high-temperature thermoelectric elements and a second stage containing lower temperature thermoelectric elements. The stages are connected in thermal series by means of an elongated heat transfer pipe containing a liquid metal and a wick. A portion of the heat radiated to the first stage from a high-temperature radioisotope source is converted to electricity. The heat rejected by the first stage is conducted to the heat pipe and absorbed by the liquid metal as latent heat of vaporization. The vapor rises to the second stage and condenses to give up latent heat of condensation which is transferred to the second stage and is converted to electricity therein. The condensed liquid returns on the wick to the vicinity of the first stage. (Official Gazette)

40762 U. S. NAVY RADIOISOTOPIC POWER GENERATOR PROGRAM. Cope, R. P.; Fleming, T. P. (Naval Facilities Engineering Co., Washington, D. C.). Isotop. Radiat. Technol.; 9: No. 3, 323-9(Spring 1972).

The Navy Radioisotopic Power Generator (RPG) Program is managed and administered by the Naval Facilities Engineering Command (NAVFAC) and its field office, the Naval Nuclear Power Unit. The RPGs convert heat directly to electricity, operating on the thermocouple principle, and are used in inaccessible areas where long-life unattended power sources are required. Current prices of RPGs range from $45.5 thousand for an 8-W unit to $63.7 thousand for a 25-W unit. Units that produce up to 2 kW are expected to be available by 1976, and near-future Navy efforts are expected to be concentrated in the higher power units. (auth)

40763 DIRECT ENERGY CONVERSION TODAY. PART 1. Euler, Karl Joachim (Gesamthochschule, Kassel, Ger.). VDI (Ver. Deut. Ing.) Z.; 114: No. 8, 550-3(Jun 1972). (In German).

Work on methods for direct energy conversion has recently been stimulated by the public interest in improved environmental pollution control. In the field of magnetohydrodynamic generators the Soviet Union has put into operation the first trial power plant. Other power plants will follow in the near future in other countries. A compact small nuclear reactor equipped with thermionic fuel elements now is under development in the Federal Republic of Germany. Flame-fired thermoelectric generators in the power range up to 100 W are manufactured in series in the USA. The development of radioactive nuclide batteries is of importance in marine technology, in medical electronics, and as energy sources for wrist watches. Finally, it can be predicted that portable power sources in the range of 100 W to 10 kW will be the first commercial application of electrochemical fuel cells. (auth)

Facilities and Equipment

Refer also to abstracts 41351, 41390, and 42060.

40764 (HEDL-TME-71-63) COMPARISON OF THE FLUTED VALVE AND ORIFICE PLATE PLUGGING METERS. Meadows, G. E. (Hanford Engineering Development Lab., Richland, Wash.). May 1971. Contract AT(45-1)-2170. 32p. Dep. NTIS.

The operating characteristics of two plugging meters have been studied. The meters located on the same sodium facility were subjected to four levels of sodium purity covering a concentration range of interest to operators of large sodium facilities. Two modes of meter operation were used: determination of plugging temperature obtained by starting with a bare restrictor and determination of saturation temperature obtained by operating the meters in the oscillating mode. The objective of the study was to supply comparative data required to select a "standard" plugging meter for the FFTF and FFTF support facilities. Selection of the orifice plate plugging meter was recommended for FFTF and FFTF Test Facilities. This selection was based primarily on superior performance of the orifice plate meter during determination of the saturation temperature when operated in the oscillating mode. (auth)

40765 (HEDL-TME-71-130) COMPARISON OF THE STACKED FOIL FILTER AND THE ORIFICE PLATE PLUGGING TEMPERATURE INDICATORS. Meadows, G. E. (Hanford Engineering Lab., Richland, Wash.). 10 Sep 1971. Contract AT-(45-1)-2170. 21p. Dep. NTIS.

The operating characteristics of two plugging temperature indicators have been studied. The plugging temperature indicators located on the same sodium facility were subjected to four levels of sodium purity and to four operating temperatures. Two modes of plugging temperature indicator operation were used: determination of the plugging temperature obtained by starting with a bare restrictor and determination of the saturation temperature obtained by operating the indicators in the oscillating mode. The study was conducted to evaluate the filter plugging temperature indicator design as a possible supplemental or replacement plugging temperature indicator for the orifice plate plugging temperature indicator design which had been previously selected as the "standard" design for the FFTF and FFTF support facilities. Results of testing of the two indicators did not indicate any advantages of the filter plugging temperature indicator over the orifice plate plugging temperature indicator. (auth)

40766 (ORNL-TM-3840) PRELIMINARY MEASUREMENTS OF THE PERFORMANCE OF A LARGE HORIZONTAL CONDENSER BUNDLE IN THE MSF MODULE. Van Winkle, R. (Oak Ridge National Lab., Tenn.). Jul 1972. Contract W-7405-eng-26. 28p. Dep. NTIS.

Temperature measurements were made on the steam side of the large horizontal-tube bundle of the MSF Module during experiments in which varying amounts of noncondensables were intentionally introduced. Many of the temperature sensors showed significant changes following introduction of gas and were influenced also by the vent rates. Vent rates of $\frac{1}{2}$ to 1 percent of total vapor flow appeared to be as effective as higher rates. Good agreement was obtained between observed and calculated pressure drop. A discussion is given of the Module bundle instrumentation. (auth)

40767 ELECTRIC WELDING MACHINE SAFETY DEVICES (Engineering Materials). (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). (CAPE-2219).

4 drawings.

Two safety devices can be installed on electric welding machines to protect personnel from electric shock. Since some welding operations require ungrounded welding, an equipment failure in a welding machine during such operations can cause dangerous voltages to exist on the welding electrodes and expose personnel to electrical shock hazard. One of these safety devices is designed for use on electric arc welders and provides an audible alarm if voltage from either electrode to ground on the welding machine exceeds a safe value. The other device is used on percussion-type spot resistance welders to prevent dangerous voltages between either electrode and ground. These safety devices operate without auxiliary sources of power and do not restrict operating flexibility of welding machines. A machine may be operated with either of the welding electrodes grounded, or with both electrodes ungrounded, without affecting the integrity of the safety devices. Fabrication, installation, and operating instructions are included on the drawings to assist manufacturers or users of electric welding machines or related equipment in using the devices as personnel safety features. (For details see TID-4100 Suppl. 71). (F.S.)

40768 VAPOR GENERATOR FOR OPERATION BY LIQUID METAL OR MOLTEN SALTS. (to Combustion Engineering, Inc.). British Patent 1,275,298. 24 May 1972. Priority date 16 Aug 1968, United States.

Designs applicable to vapor generators for operation by high temperature liquid metals or molten salts as the heating medium are described. Superheated vapor is produced in an elongated pressure vessel having a plurality of pressure tubes connected between a lower shell and an upper vapor collection chamber and traversing a heat exchanger chamber. (J.R.D.)

40769 IMPROVEMENTS IN OR RELATING TO PRESSURE RELIEF DEVICES. Taylor, Derek; Watts, Michael John (to United Kingdom Atomic Energy Authority). British Patent 1,276,838. 7 Jun 1972. Filed 18 Jul 1968.

Reference is made to pressure relief devices suitable for use in liquid metal/water heat exchange systems. The arrangement described consists of a duct having a membrane that normally prevents fluid flow in the duct. On the downstream side of the membrane is a membrane support member, pivotable from a position in which it supports the membrane to a position where it ceases to support the membrane. This support member is retained in the supporting position by a shear pin that is designed to fail, together with the membrane, at a predetermined fluid pressure on the membrane. A second membrane is also provided downstream of the first membrane and clear of the pivoted arc of the supporting member; this membrane provides a hold-up for fluid in the event of premature opening or malfunctioning of the device. Means for detecting leakage through the first membrane may be provided. Ni sheet is a suitable membrane material for use with Ne. Alternative designs of heat exchange system employing the device are described. (UK)

40770 HOW TO CALCULATE TEMPERATURE DISTRIBUTION IN THE VALVES OF LIQUID METAL SYSTEMS. Andreev, A. M.; Sokovishin, Yu. A.; Shelukhin, A. S. This paper was summarized in At. Energ. (USSR); 31: No. 3, 270(Sep 1971) as paper No. 524/6140. (In Russian).

Full copy of this paper is held by TIC.

Discussions are presented of calculation methods applicable to designs in which the bottom of the globe valve is thermally insulated, while the valve topworks are cooled by natural convection and by radiation. It is assumed that the total volume of dead pockets above the pilot valve in this globe valve will be filled with coolant, the thermal conductivity of which will be close to the thermal conductivity of the structural material. A system of equations is developed in which the heat-transfer coefficients are treated as additive constants, and their value is determined by the mean-integral value over each interval in the calculations. Comparison of the solution so obtained and experimental results demonstrates that the procedure proposed for calculating temperature distributions in valves may be used in practice with assurance of accuracy sufficient for engineering purposes. (J.R.D.)

40771 PRESSURE DROPS AND THERMAL TRANSFER (GAS SIDE) IN HEAT EXCHANGERS WITH CROSS FLOW OVER BARE TUBE BANKS. Boissier, Andre (Electricite de France, Chatou); de Chatillon, Michel; Gautier, Daniel; (and others). Bull. Dir. Etud. Rech., Ser. A; No. 2-3, 5-241(1971). (In French).

Results of research carried out for nuclear reactor heat exchangers are presented. The following topics are discussed: an error calculation; a detailed study of the three facilities used; special studies carried out. These special studies enabled the major difficulties encountered to be brought to the surface and problems, which might adversely affect the good representation of the mockups, to be avoided. Gas side pressure drops and heat transfer relations are proposed for infinite exchangers; they represent a 5-year study period involving 4000 experiments. (France)

40772 IRRADIATION APPARATUS. Green, W. R. (to Atomic Energy of Canada Ltd.). Canadian Patent 893,392. 15 Feb 1972.

An apparatus is described for the irradiation of products requiring at least a high initial radiation intensity followed by irradiation at a relatively lower intensity. A product support rack moves through an opening into, out of, and around the outside of a hollow elongate source rack. During irradiation the product support is cooled by jets of liquid which also act to rotate the product support by impinging on vanes on it. Apparatus is provided for scheduling the movement and timing of the containers. (Canada)

40773 PROBABLE APPLICATIONS OF NUCLEAR ENERGY TO BLAST FURNACE PROCESS WITH AN EMPHASIS ON DIRECT INJECTION OF REFORMED GAS INTO FURNACE STACK. Kobayashi, Tadashi; Nakatani, Fumitada; Okabe, Kyoji; Miyashita, Tsuneo (Iron and Steel Inst., Tokyo). Trans. Iron Steel Inst. Jap.; 11: No. 6, 412-23(Nov 1971).

In the iron and steel industry utilization of nuclear energy has become one of the most urgent problems for reasons of pollution abatement and coping with coal shortages. The generally adopted method for the application of nuclear energy is based on how the energy can be converted into heat for reducing gas generation and for a supply of reaction heat for iron reduction. The behavior of blast furnaces during injection of reducing gas into the furnace shaft was investigated by means of three different calculation methods. The first of these three methods was applied by the use of the operation diagram proposed by Rist. The results show that the costs of reducing-gas should be lower than 2 to 3 yen/Nm^3. The second method was used to solve a series of equations based on the heat and material balance of the total furnace under the conditions of reducing gas injection. The third is based on the solution of a math model simulating chemical reactions and heat transfer in the furnace shaft. The results indicate the cost increase of 570 to 1,090 yen/t of iron when the reducing gas injection is applied. Several examples are proposed to install the nuclear reactor. (auth) (Japan)

Heat Transfer and Fluid Flow

Refer also to abstracts 40768, 40770, 40771, 41000, 41024, 41421, 41466, 42601, 42603, and 42645–42650.

40774 (AEC-tr-7309) CRITICAL FLOW RATES IN WATER-VAPOR DIPHASIC FLOW. Final Report. Boure, J.; Reocreux, M.; Barriere, G.; Flamand, J. C.; Schipfer, P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Translation of report TT No. 106. 174p. Dep. NTIS.

In order to understand the phenomenon of critical flow in gas-liquid flow numerical models were developed for predicting the critical flow rate and for interpreting test data, and test equipment was developed for producing, visualizing, and measuring critical flow conditions. Previous studies on critical flow are reviewed. The design and construction of test loops for air—water flow experiments are described in detail. The development and use of numerical models for predicting critical flow are discussed. Plans for actual tests are presented. (L.C.L.)

40775 (COO-2032-11) MEASUREMENT OF THE CONDENSATION AND EVAPORATION COEFFICIENTS OF WATER. Narusawa, Uichiro (Michigan Univ., Ann Arbor. Dept. of Mechanical Engineering). 1972. 53p. Dep. NTIS.

Thesis.

Mass transfer rates at a flat water surface were measured during evaporation of the water into its own vapor. The experiments were performed for water surface temperature T_s ranging from 19 to 27°C and for pressure differences $(P_s - P_v)$ up to 1.4 mm Hg, where P_v is the vapor pressure and P_s the saturation pressure corresponding to T_s. The surface temperatures were determined accurately by measuring the intensity of the infrared radiation emitted from the surface. The condensation β_c and evaporation β_e coefficients were evaluated using the obtained data together with the analytical expression of Schrage, Patton and Springer, and Shankar and Marble. The results show that in the range of present experiments, the two coefficients are equal $(\beta_c = \beta_e = \beta)$. Schrage's analysis resulted in $\beta = 0.0375$, Patton and Springer's expression gave $\beta = 0.0380$, while Shankar and Marble's result yielded $\beta = 0.0195$. The effect of thermal accommodation on β was also evaluated. It was found that for thermal accommodation coefficient (α) above 0.3 the value of β is insensitive to α. (auth)

40776 (KFK-1554) THE SOLUTION OF HEAT CONDUCTION AND CONVECTION PROBLEMS BY THE MONTE-CARLO METHOD. Kirsch, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Feb 1972. 25p. (In German). Dep. NTIS (U. S. Sales Only).

The principles of the solution of the energy equation using the Monte Carlo method are described. Examples are given for the solution of heat conduction problems and for the solution of a heat convection problem with constant fluid properties. One of the examples is used to illustrate the correctness of the method. A finite difference representation of the energy equation is suggested, which is adapted to the Monte Carlo method and suitable for the treatment of heat convection problems under transient conditions. In heat convection problems with the Monte Carlo method, if temperature-dependent fluid properties have to be accounted for, the Monte Carlo method is not qualified. (auth)

40777 (RT/ING-(71)22) HEATER SIMULATION OF FUEL ELEMENTS TO TEST HEAT EXCHANGE IN SODIUM AT HIGH TEMPERATURE. Falzetti, L.; Tomassetti, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 22 Dec 1971. 45p. (In Italian). (CONF-710952-2). Dep. NTIS (U. S. Sales Only).

From Symposium of the Italian Thermotechnical Association; l'Aquila, Italy (21 Sep 1971).

A heater developed at USTS and utilized for experiments concerning PEC reactor fuel element thermomechanical and thermohydraulic operation is described. An analysis of operating conditions, of project limitations, of possible solutions shows what has been done for the solution of this important technological problem. Original solutions are covered by a patent. (auth)

40778 TURBULENT MIXING FOR AIR-WATER FLOWS IN SIMULATED ROD BUNDLE GEOMETRIES. Rudzinski, K. F.; Singh, K.; St. Pierre, C. C. (Univ. of Windsor, Ont.). Can. J. Chem. Eng.; 50: No. 2, 297-9(Apr 1972).

Subchannel analysis of two-phase flow mixing provides information which is useful in the prediction of critical heat flux in fuel for water-cooled power reactors. In this study mixing rates were measured in the absence of cross flows using a two component two-phase air-water system operating at 50 psia. Tracers were employed to obtain simultaneous measurement of mixing rates for each component in square-square and triangular-triangular subchannel arrays. The variation of mixing rates with subchannel quality and the relation of subchannel quality to mixing quality were determined. Air and water mixing rate maxima were found to occur at different qualities in the slug flow regime. (Canada)

40779 TWO-PHASE FLOW STRUCTURE AND MIXING LENGTH THEORY. Beattie, D. R. H. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nucl. Eng. Des.; 21: No. 1, 46-64(1972).

A statistical approach to two-phase inertia forces leads to a mixing length theory in which different flow structures correspond to different flow regimes. The theory is used in conjunction with void and velocity profile data to examine developing and developed flow profiles for bubble and dispersed annular flows. One- and two-component flows are considered for various channel geometries. Asymmetric profiles such as those that result from asymmetric heating or horizontal flows are also described by the theory. In the case of annular flows, liquid film thickness measurements are consistent with the theory. Shear stress data suggest a Prandtl mixing length constant slightly less than that for single phase flow theory. The core profiles at the boiling crisis condition are consistent with a local reduction of the liquid film to zero thickness. (auth)

40780 EXPERIMENTAL INVESTIGATION OF THE HEAT TRANSFER TO LIQUID METALS RUNNING IN PARALLEL FLOW THROUGH PIPE BUNDLES. Graeber, H.; Rieger, M. (EURATOM, Ispra, Italy). pp 154-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The relation between Nusselt number, Peclet number, pipe distance, and heat flux distribution has been measured for pipe bundles containing the liquid metal alloy NaK. The measured Nusselt numbers are compared with theoretical results and lead to heat transfer numbers that are 20% lower than the theoretical predictions. (INIS)

40781 EXPERIMENTAL INVESTIGATION OF SODIUM BOILING SUPERHEATING CAUSED BY ARTIFICIAL SURFACE ROUGHNESS. Schultheiss, G. F. (Kernforschungszentrum, Karlsruhe, Ger.). pp 158-61 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Results of experimental investigations are reported on the thermohydraulic and physicochemical reactions of superheating in boiling sodium. The test surface material, the geometry of an artificial cavity, and the concentration of sodium oxide were used as experimental parameters. Stainless steels No. 4541 and No. 4571 were used as test materials. (INIS)

Materials Testing

Refer also to abstracts 41018, 41391, 41422, 41425, 41441, and 41503.

40782 MANUAL ON LOW CYCLE FATIGUE TESTING. ASTM Special Technical Publication 465. Philadelphia; American Society for Testing and Materials (1969). 201p. $12.50.

Information is presented in papers on mechanics of materials in low-cycle fatigue testing, basic research on cyclic deformation and fracture behavior of materials, low-cycle fatigue testing facilities, elevated temperature testing methods, controlled-strain testing procedures, high-temperature materials behavior, engineering materials evaluation by reversed bending, and thermal fatigue evaluation. (J.R.D.)

40783 IN-SERVICE INSPECTION OF REACTOR VESSEL WELDS. Diwinsky, Gordon A.; Kosky, Richard P. (to Combustion Engineering, Inc.). U. S. Patent 3,664,922. 23 May 1972. Filed 18 Dec 1969.

Method and apparatus are described for in-service inspection of nuclear reactor vessel welds. A support mechanism housing an inspection device is positioned within the reactor vessel after the internal structures are removed. The hoist mechanism for the refueling device is then used to manipulate the inspection device from its support mechanism to the weld areas to be inspected. The inspection device includes means for remote visual and volumetric examination of the cladding and weld surfaces, respectively, as well as a displacement indicating means for determining the position of the inspection device with respect to the weld being inspected. (Official Gazette)

40784 ULTRASONIC DATA ANALYSIS USING A COMPUTER. **Sachs, R. D.; Elkins, J. D.; Smith, J. H. (Union Carbide Corp., Oak Ridge, Tenn.). Mater. Eval.; 30: No. 6, 121-5; 135(Jun 1972).**

A digital computer was used to analyze the data obtained from the ultrasonic inspection of a weld. The computer is interfaced to a standard ultrasonic flaw detector and to the scanning mechanism. The computer can automatically determine the size of a flaw and its location on the test part as the test is being conducted semiautomatically. (auth)

40785 MIXTURE OF A RADIOACTIVE TRACER SUBSTANCE AND A PROPELLENT FOR USE IN DRILLING TOOLS. (to Farbwerke Hoechst Aktiengesellschaft). British Patent 1,276,311. 1 Jun 1972. Priority date 14 Jun 1968, Germany.

A mixture comprising a radioactive tracer, finely divided Al powder, and an alkali metal peroxide is described for deposit in cavities of deep well drill tools. The mixture explodes at contact with water to act as primer for an explosive such as ammonium picrate. The explosive, upon initiation, produces gas which drives the radioactive tracer from the cavity. The entire reaction is initiated when the drill tool wear exposes the embedded mixture thus signalling maximum allowable tool wear. (J.R.D.)

40786 CONTRIBUTION TO THE PROBLEM OF MEASURING THE CROSS-SECTION OF ROUND WIRE ROD AND ROUND STEEL BARS BY MEANS OF THE COMPTON SCATTERING OF HARD γ-RADIATION. Hoeller, Paul; Thoma, Christian (Thyssen Niederrhein AG, Oberhausen, Ger.). Arch. Eisenhuettenw.; 43: No. 3, 263-9(Mar 1972). (In German).

Discussions are presented on optical measuring methods, delimitation of the possibilities of measurement when making use of the interaction with hard γ-rays, photoelectric effect, Compton scattering, pair production, dependence of the signals of measurement on steel composition and changes of the position of the wire, comparison of absorption with scattering, establishment of an arrangement for 90 degree Compton scattering, calculation of the signals, and comparison of the results with the calculated values. (auth)

40787 ENLARGEMENT TECHNIQUE REALISED WITH A 18 MeV BETATRON. **Nardoni, G.; Berzolla, A. Met. Ital.; 63: No. 8, 399-404(Aug 1971). (In Italian).**

The enlargement technique applied to the examination of heavy wall-thickness welds is described. The experiments carried out with a 18-MeV betatron (focus 0.2 × 0.3 mm) were conducted to identify types of defects not revealed by normal techniques. These tests demonstrated that the images of such defects may become evident on the radiography only by magnifying the primary radiant image. This technique may be realized only with point shaped or very small focus. In addition to the results obtained with the betatron, experience on the enlargement techniques realized with a 400-keV equipment having focus dimension of 4 × 4 mm is described. (auth)

40788 ULTRASONIC TEST FOR WELDINGS OF FAST BREEDER FUEL PINS. **Albertini, C.; Montagnani, M.; Verzeletti, G. (EURATOM-CCR, Ispra, Italy). Met. Ital.; 63: No. 8, 395-8(Aug 1971). (In Italian).**

The welding of a plug to a can for a pin for a fast breeder reactor was examined nondestructively. The welding made by explosion had a wide overlap between the plug and the can. An ultrasonic transmission test with a focalized emitter was used. The system gives an on-off signal which permits evaluation of the welds at a high confidence level. The system can be used for testing in an automatic explosive welding machine which is under construction. (auth)

40789 MONITORING OF CERAMIC SAMPLES FOR MAGNETIC IMPURITY. **Allen, John Edward Stuart; Ledwidge, Thomas Joseph (to United Kingdom Atomic Energy Authority). British Patent 1,276,867. 7 Jun 1972. Filed 9 Dec 1969.**

Reference is made to methods for monitoring ceramic materials to determine the level of magnetic impurities, such as Fe and Ni, therein, with particular regard to nuclear fuel materials. The method described employs the well-known magnetic susceptibility measurement technique, based on the measurement of the force exerted on a magnetic material when placed in a non-uniform magnetic field. The sample is suitably mounted so as to deflect the free end of a cantilever beam, and is subjected to a non-uniform magnetic field; the field acts on the magnetic impurity so as to strain the beam, and the strain is measured. The beam may comprise a glass fibre, with the strain measured by gauges attached to the beam near its supported end. The beam may be reduced in section where the strain gauges are attached, in order to "amplify" its deflection, and the strain gauges are preferably in the form of a strain gauge bridge. The strain on the beam emanates from two sources: the weight of the sample and the force created by application of the magnetic field. If these two forces are applied sequentially the first can be cancelled out by "backing off" the meter associated with the bridge. This meter can be calibrated in terms of "impurity content" or used merely at "accept" or "reject" levels. (UK)

40790 NEW VARIATIONAL FUNCTIONAL FOR THE FINITE-ELEMENT METHOD AND ITS APPLICATION TO PLATE AND SHELL PROBLEMS. Kikuchi, Fumio; Ando, Yoshio (Tokyo Univ.). Nucl. Eng. Des.; 21: No. 1, 95-113(1972).

A new variational functional for the finite-element method is derived by using the Lagrange multiplier method. The derived functional is very general and almost all the functionals ever used in the finite element analysis are included as its special cases. For practical applications, a stiffness matrix of a triangular finite element for plate and shell problems is derived and numerical examples are illustrated to demonstrate the validity of this method. (auth)

40791 CHARACTERISTICS OF LEAD FOIL SCREENS ON ^{60}Co RADIOGRAPHY. II. **Tsujii, Yukio; Furuta, Junichiro; Hiraoka, Eiichi. Annu. Rep. Radiat. Center Osaka Prefect.; 12: 76-7(1971).**

Detailed checks of defect sensitivity in ^{60}Co γ-ray radiography were made using a Bacillus-type penetrameter. The defect sensitivity is independent of the front screen thickness. The accuracy of defect sensitivity observed by the usual wire penetrameter was no more than 50% with a Bacillus-type penetrameter. (auth)

Nuclear Explosions

Refer also to abstracts 40830, 40869, 40870–40872, 40874, and 40875.

40792 (EERO-TR-7) PREDICTION OF AIRBLAST OVERPRESSURES FROM UNDERGROUND EXPLOSIONS. Snell, Charles M.; Oltmans, Dennis L.; Leahy, Edward J. (Army Engineer Explosive Excavation Research Office, Livermore, Calif.). Aug 1971. 44p. Dep. NTIS.

Two methods are presented for predicting airblast overpressures from underground chemical explosive and nuclear detonations. The first method utilizes empirical scaling techniques to predict both ground-shock-induced and gas-vent-induced overpressures. Empirical procedures are also provided for predicting airblast from underground row-charge and array detonations and from surface or near-surface bursts. The second method uses peak vertical spall velocities combined with basic physical principles to predict ground-shock-induced overpressures. With the use of one or both of these methods, it is possible to predict airblast overpressures caused by detonations at scaled depths of burst from zero to 700 ft/kt$^{1/3}$ in a wide variety of media. (auth)

40793 (NVO-103(Rev.2)) REPORTS AVAILABLE IN THE ALASKAN INFORMATION PROGRAM. (Nevada Operations Office (AEC), Las Vegas). 30 Apr 1972. 13p. Dep. NTIS.

Since the U. S. Atomic Energy Commission (AEC) selected Amchitka Island, Alaska, as a location for higher-yield underground nuclear tests, the Nevada Operations Office (NV) of the AEC has conducted a continuing program to acquaint the public with the facts of the test program and the measures being taken to assure the safety of the public and test participants, as well as assuring the protection of the environment. As a part of this overall program, the NV has established "open file" depositories in Alaska at which unclassified scientific and technical reports relating to the AEC's Amchitka Island activities are readily available to the public. Those documents that have been provided to the open files as of April 30, 1972, are listed. (auth)

40794 (NVO-289-8) WAVE GENERATION BY BEACH DISPLACEMENT. Final Report. Hwang, Li-san; Tuck, E. O. (Tetra Tech., Inc., Pasadena, Calif.). Nov 1970. Contract AT-(26-1)-289. 86p. (TC-174-2; TETRAT-P-71-174-2). Dep. NTIS.

A general solution of the linear long wave equation is obtained for arbitrary ground motion on a uniformly sloping beach. Numerical results are presented for specific shapes and time histories of ground motion. Near shore large amplitude waves are also investigated using nonlinear theory. (auth)

40795 (NVO-289-9) NUMERICAL STUDIES OF SURFACE WAVE GENERATION BY BOTTOM MOTION. Draft Final Report. Hwang, Li-san; Divoky, David; Butler, Lee (Tetra Tech, Inc., Pasadena, Calif.). Sep 1970. Contract AT(26-1)-289. 52p. (TC-174-3; TETRAT-P-71-174-3). Dep. NTIS.

The equations governing surface wave generation by an arbitrary displacement of the sea bed are derived from the Euler equation. The bottom deformation may be arbitrary in both geometry and time history. The numerical computation techniques are described and the model is applied to evaluate wave generation during the Milrow Event. Both doming and hypothetical faulting are considered as the source mechanism. In each case the outgoing wave system is vanishingly small beyond a small multiple of the source dimension. Speculations concerning possible wave generation during Cannikin are presented based upon the Milrow results. The problem of tsunami generation in the Rat Island area is given cursory attention with discussion of directionality of wave energy radiation. (auth)

40796 (NVO-289-10) RAT ISLANDS TSUNAMI MODEL: GENERATION AND OPEN-SEA CHARACTERISTICS. Progress Report. Hwang, Li-san; Butler, H. Lee; Divoky, David (Tetra Tech., Inc., Pasadena, Calif.). Sep 1971. Contract AT(26-1)-289. 77p. (TC-239). Dep. NTIS.

A brief description of a computer program developed for calculating tsunami wave generation and propagation is given. The equations governing the wave motion are partially linearized and written in a spherical coordinate system. The numerical model is applied to evaluate wave behavior generated by the Rat Islands tsunami and the Alaskan tsunami. Results of computation were compared with field measurement (Wake Island deepwater gage records) and those obtained from the numerical model developed previously. Finally, the problem of tsunami generation and propagation in the Rat Island area is given special attention and discussions of directionality of wave energy radiation both in the direction of the Bering Sea and the Pacific Ocean are stressed. (auth)

40797 (ORNL-TM-3755) PROGRESS REPORT ON RADIOLOGICAL SAFETY OF PEACEFUL USES OF NUCLEAR EXPLOSIVES: PRELIMINARY EQUATIONS AND COMPUTER TECHNIQUES FOR ESTIMATING AND CONTROLLING TRITIUM DOSES FROM NUCLEARLY STIMULATED NATURAL GAS. Moore, R. E.; Barton, C. J. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 73p. Dep. NTIS.

An equation is derived for expressing the tritium concentration in dry natural gas flowing from a nuclearly stimulated well as a function of the volume of gas removed from the well, the initial number of curies of tritium in the hydrocarbons and hydrogen in the chimney, and a factor equal to 1 (volume of gas flowed into the chimney from the rock formation divided by the volume of gas removed). Computer programs based on this equation which calculate the tritium concentration in gas flowing from multiple-well fields are described. They are designed to aid in scheduling the opening of wells in these fields so as to control the tritium concentration and the tritium doses received by persons exposed to gas combustion products. The procedure used in calculating tritium doses received by persons exposed to stack emissions from a power plant burning the gas is outlined. A computer program is described that will compute the annual tritium dose received by any person living in the vicinity of such a power plant. A related program is also described that will compute the maximum tritium concentration, averaged over a one-year period, which would be permitted in gas burned in a power plant so that no person would receive more than a predetermined annual tritium dose. Details and examples of the use of the computer programs are presented, including all the information needed to use the four programs. (auth)

40798 (SC-RR-710668) GROUND MOTION IN THE VICINITY OF AN UNDERGROUND NUCLEAR EXPLOSION IN THE ALEUTIAN ISLANDS: MILROW EVENT. Perret, William R.; Breding, Dale R. (Sandia Labs., Albuquerque, N. Mex.). May 1972. 87p. Dep. NTIS.

The Milrow Event was an underground nuclear explosion detonated October 2, 1969, 4000 ft beneath Amchitka Island. Subsurface and surface ground motion observations made during this event are reported. Subsurface motion recorded at six stations in borings offset 300 ft from the explosive at depths between 100 and 2000 ft indicates that acceleration decreased as the inverse 1.6-power of distance and particle velocity as the inverse 1.45-power of distance from the explosion. Spallation was found to have occurred at depths between 100 and 300 ft, between 300 and 500 ft and probably below 500 ft. Surface motion recorded at 10 stations ranging from 250 to 32,000 ft from surface zero included typical spall patterns out to 17,000 ft. Maximum vertical displacement near surface zero was 170 in. Two stations on opposite sides of the Rifle Range fault showed negligible strike-dip residual displacement, but about 3 in. right lateral strike-slip which compares favorably with results from a nearby survey strain net. Displacement hodographs show onset of Rayleigh wave motion between horizontal distances of one-half to one times shot depth. (auth)

40799 SEISMOLOGICAL EVIDENCE FOR A LITHOSPHERIC TEARING BENEATH THE ALEUTIAN ARC. Abe, Katsuyuki (Tokyo Univ.). Earth Planet. Sci. Lett.; 14: No. 3, 428-32 (Apr 1972).

Travel times have been studied from the Longshot underground explosion detonated on Amchitka Island on Oct. 29, 1965. The travel-time residuals of P waves at stations in azimuths from N10°E to N30°E around the source are, on the average, larger by 1 to 2 s than those at stations in adjacent azimuths. This observation suggests the existence of a low-velocity region having a limited spatial extent; a P-velocity contrast of 0.3 to 0.6 km/s is estimated. This low-velocity region can be explained in terms of a lithospheric tearing beneath the Aleutian arc and of a subsequent intrusion of low-velocity material from the underlying asthenosphere. The lithospheric tearing is considered to have been caused by bending of the oceanic lithosphere at a markedly curved portion of the Aleutian arc. (auth)

40800 MORE ON THE MER. Cohen, J. J. (Univ. of California, Livermore). Health Phys.; 23: No. 1, 124-5(Jul 1972).

A reply is made to some comments received regarding the author's paper on Plowshare (Health Phys. 21: 337(1971)). (UK)

40801 CRITERIA FOR RADIONUCLIDES IN NATURAL GAS SUPPLIES. Cohen, J. J. (Univ. of California, Livermore). Health Phys.; 23: No. 1, 124(Jul 1972).

A reply is made to Major's comments (Health Phys. 21: 611 (1971)) on the author's paper in Health Phys. 19, 633(1970). (UK)

40802 METHOD OF STIMULATING OIL OR GAS RESERVOIRS BY A SUBSURFACE NUCLEAR EXPLOSION. Dunlap, Henry F. (to Atlantic Richfield Co.). U. S. Patent 3,659,649. 2 May 1972. Filed 27 May 1968.

A nuclear explosive device for subsurface use is assembled and detonated through a small diameter borehole by enlarging a section of the borehole to a sufficient size, lowering a triggering device into the enlarged section and placing nuclear explosive fuel material around the trigger. The nuclear fuel material is surrounded by a second material which may be of higher density and may also be a fuel material. Heavy water may be injected into or with the nuclear fuel material. The nuclear fuel material may contain the deuteride of an active metal substance and be slurried with an anhydrous liquid; or it may contain the heavy hydrogen isotope of the hydroxide of the active metal substance and be slurried with heavy water. Concentric collapsible, expansible containers are used to form the nuclear explosive. (Official Gazette)

40803 SURFACE-WAVE AND BODY-WAVE MAGNITUDES OF SOME SINO-SOVIET NUCLEAR EXPLOSIONS AND EARTHQUAKES. Gupta, Harsh K.; Sitaram, M. V. D.; Narain, Hari (National Geophysical Research Inst., Hyderabad, India). Bull. Seismol. Soc. Amer.; 62: No. 2, 509-17(Apr 1972).

Body-wave and surface-wave magnitudes were determined for the Sino-Soviet nuclear explosions and earthquakes in nearby regions using National Geophysical Research Institute's seismological observatory data. On a M_S versus m_b plot, the two are clearly distinguished. The following relations hold good between M_S and m_b: $M_S = 0.70\ m_b + 1.88$ for earthquakes and $M_S = 1.06\ m_b - 1.46$ for explosions. A comparison with an analogous study involving only continental seismic paths for North American explosions and earthquakes shows that our findings are consistent for earthquakes whereas for explosions, NGRI M_S values are systematically lower. (auth)

40804 HIGHRISE BUILDING CHARACTERISTICS AND RESPONSES DETERMINED FROM NUCLEAR SEISMOLOGY. Blume, John A. (Blume and Associates Research Div., San Francisco). Bull. Seismol. Soc. Amer.; 62: No. 2, 519-40(Apr 1972).

Reliable measurements and detailed analyses of the responses of many buildings to ground motion resulting from underground nuclear explosions are providing new and valuable information on the structural-dynamic properties and behavior of real buildings. Much, if not all, of this knowledge is applicable to the problem of resisting natural earthquake ground motion, and it is being obtained as a byproduct of the AEC underground explosive nuclear safety program which is concerned with developing techniques for making reliable predictions of response and any damage. Information is provided on oscillator spectral response values, building responses, modal contributions and combinations versus elapsed time and at times of maximum response, variations in natural periods, foundation material interaction, and biaxial motion in the horizontal plane. Data are shown for nuclear events Jorum and Handley and then compared to those of prior major events. In addition, peak responses of certain Las Vegas buildings to the distant February 1971 San Fernando earthquake (U. S. Geological Survey, 1971) are provided and compared to responses to nuclear events. (auth)

40805 STRESS CHANGES IN ROCK FROM THE JORUM UNDERGROUND NUCLEAR EXPLOSION, SEPTEMBER 16, 1969, PAHUTE MESA, NEVADA TEST SITE. Lee, Fitzhugh T.; Nichols, Thomas C. Jr. (Geological Survey, Denver). Bull. Seismol. Soc. Amer.; 62: No. 2, 609-18(Apr 1972).

The Jorum underground nuclear explosion, September 16, 1969, at the Nevada Test Site, induced a series of short- and long-duration stress changes in the nearby rock. These changes were monitored with solid-inclusion three-dimensional probes that were emplaced in drill holes at four locations. The stress in the nearby rock mass stabilized within 2 weeks after the explosion but in all instances a relatively more tensile stress equilibrium was reached. The stress-change directions resulting from the explosion were closely aligned with prominent fault and joint-system trends. There was good agreement of changes in stress magnitude and direction with postshot seismic activity, alignment of aftershock epicenters, and structural directions. The relationship between geological features, seismic activity, and stress changes strongly suggests that the explosion-triggered release of stored tectonic strain energy is controlled by preexisting geological conditions. (auth)

40806 ANALYSIS OF AMPLITUDE SPECTRA OF P WAVES FROM EARTHQUAKES AND UNDERGROUND EXPLOSIONS. Hasegawa, H. S. (Dept. of Energy, Mines, and Resources, Ottawa). J. Geophys. Res.; 77: No. 17, 3081-96(10 Jun 1972).

A step-by-step display of the theoretical P-wave amplitude spectrum of shallow (focal depth ≤40 km) earthquakes with m_b values ranging from 5.9 to 6.3 and underground explosions of comparable magnitudes as the signal propagates from source to receiver indicates that the factors most influential in shaping the respective spectra are the source crust transfer function, which includes the focal depth effect, and the source function. The results, although not unequivocal, favor a peak in the amplitude spectrum of the teleseismic P coda of earthquakes rather than a flat spectrum at low frequencies. The effect of focal depth appears to have more influence than the effect of source parameters on the peak frequency f_0 in the spectra of earthquakes, whereas the source function is the important parameter for shallow underground nuclear explosions. For shallow seismic events of comparable m_b the f_0 of earthquake spectra is smaller than the f_0 of explosion spectra by approximately an order of magnitude. The pronounced minimum (hole) at about 0.1 Hz in the long-period spectrum of earthquakes is associated with the focal depth effect and can be identified for several events. However, theoretically predicted holes starting at about 0.5 Hz in the short-period spectrum of assumed unilateral faulting earthquakes are due to the extended source effect and are not identifiable on any of the experimental spectra. For short-period records of Longshot and Milrow, Haskell's analytic formulation of the Werth and Herbst displacement potential, in conjunction with the outlined theory, predicts fairly accurately the increase (approximately 0.15 sec) in the duration of the first half-cycle with increasing yield. For the corresponding long-term records of Milrow his formulation predicts a value smaller than a mean of the measured values by about 15% (0.32 sec). Haskell's equations, together with the rest of the theory, appear to predict fairly accurately the variation in m_b with yield for these two events when amplitude measurements are restricted to the first half-cycle. (auth)

40807 ENERGY APPROACH TO SEISMIC COUPLING ANALYSIS. Rodean, Howard C. (Univ. of California, Livermore). J. Geophys. Res.; 77: No. 17, 3129-45(10 Jun 1972).

The explosion process is modeled by a step change in cavity pressure. The cavity is assumed to be spherical and embedded in an ideal elastic solid. This model represents a fully decoupled explosion in a cavity. It can also be used as an equivalent seismic-wave source representing a tamped explosion. A decoupling cavity existence and operating region is defined in terms of cavity and overburden pressures and the rock yield strength. The upper limit for seismic coupling efficiency for an ideal monoatomic gas is given by $E_w/E_x = 2Y/3\mu$, where E_w is the radiated seismic-wave energy, E_x is the explosion yield, Y is the rock yield function, and μ is the shear modulus. This equation may be a good approximation for the seismic-coupling efficiency of a tamped explosion, because it agrees well, perhaps fortuitously, with observations for tamped nuclear explosions in salt and granite. The seismic-energy radiation from a spherical cavity in an elastic medium is given by $E_w = 2\pi P\chi$, where P is a step change in cavity pressure and χ is the final value of the reduced displacement potential. This equation shows that the seismic-coupling efficiencies of French nuclear explosions in Sahara granite may be about equal to those of U. S. shots in Nevada granite, even though the cavity radii, elastic radii, and reduced displacement potentials for these two sets of explosions (assuming equal yields) are quite different. The theoretical seismic-energy spectra for the Nevada and the Sahara explosions are consistent with the measured spectrum for the 5-kT Hardhat explosion and overlap to a significant degree. This overlap is centered in the 0.5- to 5-Hz bandwidth and may partially explain why nuclear explosions in Nevada and Sahara granites appear to have the same magnitude-yield relation. The possibility of regional variation of seismic-signal attenuation in the upper mantle of the United States and the Sahara should also be investigated to complete the explanation of seismic coupling in Nevada and Sahara granite. (auth)

Protective Structures and Equipment

40808 (CONF-700974) SYMPOSIUM ON DESIGN OF LABORATORIES FOR WORK WITH RADIOACTIVE MATERIALS, UNIVERSITY OF BIRMINGHAM, 18 SEPTEMBER 1970. Hughes, D. (ed.) (British Radiological Protection Association Ltd.). 45p.

Seven papers were presented at the symposium. A separate abstract was prepared for each paper. (J.R.D.)

For abstracts of individual papers see: 40809–40814 and 41484.

40809 (CONF-700974–, pp 1-8) RADIONUCLIDE LABORATORIES IN UNIVERSITIES. Cullingworth, R.; Hughes, D. (British Radiological Protection Association Ltd.).

From Conference on the design of laboratories for work with radioactive materials; Birmingham, England (18 Sep 1970).

The design of laboratories for radioactive work at universities is described as distinguished from those designed for large nuclear industry complexes. Information is included on general arrangement; arrangement of floors, walls, and ceilings; design of drains; design of laboratory furniture; arrangement of power supplies; and design of ventilation systems. (J.R.D.)

40810 (CONF-700974–, pp 9-15) GRADING OF LABORATORIES AND STANDARDS OF DESIGN. Rees, J. M. (British Radiological Protection Association Ltd.).

From Conference on the design of laboratories for work with radioactive materials; Birmingham, England (18 Sep 1970).

It is noted that grading helps ensure that work with radioactive materials is not done in a seriously inadequate facility and that overelaborate facilities are not used for elementary work. Information is included on procedures for grading laboratories, standards of design, evaluation of ventilation, evaluation of washing and storage facilities, accommodation of clothing, and evaluation of laboratory furniture. (J.R.D.)

40811 (CONF-700974–, pp 17-22) SELECTION OF SURFACE FINISHES. Lucas, J. W.; Collins, J. C. (British Radiological Protection Association Ltd.).

From Conference on the design of laboratories for work with radioactive materials; Birmingham, England (18 Sep 1970).

The high cost of providing good quality surface finishes in a radioisotope laboratory may not always be justified. Readily available surface coatings based on polythene on self-adhesive PVC when coupled with good planning for the experiment, thorough training of staff, and constant attention to very high standards of cleanliness will often be adequate. On the other hand, allowance must be made for the possibility of an emergency spillage; this may be the decisive factor in arranging for high quality finish. (auth)

40812 (CONF-700974–, pp 23-30) FUME CUPBOARD DESIGN AND TESTING. Hewitt, P. J. (British Radiological Protection Association Ltd.).

From Conference on the design of laboratories for work with radioactive materials; Birmingham, England (18 Sep 1970).

The air flowing through the face of a fume cupboard must be of sufficient velocity to capture and retain contaminants under all normal operating conditions. By careful attention to design incorporating good aerodynamic features and a bypass, the very high face velocities necessary, but not found in, poorly designed fume cupboards can be avoided. The linear velocity at different points on the face should be reasonably uniform, and must not at any point fall below the specified minimum. A specified minimum face velocity should be defined in terms of the sash opening, the permitted maximum velocity at any point of the opening, and use of a standard test procedure. (auth)

40813 (CONF-700974–, pp 31-6) FUME EXTRACTION AND DISPERSAL PROBLEMS. Everett, K. (British Radiological Protection Association Ltd.).

From Conference on the design of laboratories for work with radioactive materials; Birmingham, England (18 Sep 1970).

Aspects of safe dispersal of exhaust materials from laboratory hoods into the atmosphere are discussed. Information is presented on fume extraction, choice of duct materials, and dispersal of aerosols and fumes. (J.R.D.)

40814 (CONF-700974–, pp 37-43) DESIGN OF ANIMAL HOUSES FOR RADIOACTIVE WORK. Carr, T. E. F. (British Radiological Protection Association Ltd.).

From Conference on the design of laboratories for work with radioactive materials; Birmingham, England (18 Sep 1970).

Design of accommodations for mammals used in radioactive work is described. Information is included on design features for animal husbandry facilities, design features for radioactive work, and layout of an animal house for experimental work. (J.R.D.)

40815 TRANSFER PORT ASSEMBLY FOR ELONGATED OBJECTS. (to Acieries Reunies de Burbach-Eich-Dudelange SA). British Patent 1,274,174. 17 Mar 1972. Priority date 17 Mar 1970, Luxembourg.

A transfer port assembly is described through which an elongated object of regular convex section can be passed lengthwise. An air-lock portion is included having two openings each provided with a removable, supple, variable-aperture deformable seal. The seals are operative to make sliding sealing contact with the cross-sectional periphery of an elongated object when the latter is passed through the assembly. The air-lock portion has a short length relative to the length of an elongated object to be transferred, and means, including conduits connected to the air-lock portion are provided for controlling pressure in the air-lock portion. Using such a transfer port assembly, an elongated object can be passed from one enclosure to another, with a pressure difference being maintained between the first enclosure, the air-lock portion itself, and the second enclosure, thus providing dynamic sealing tightness. The air-lock portion can contain gas or liquid which can be continuously renewed. (J.R.D.)

40816 IN-SITU TESTING OF HIGHLY EFFICIENT AEROSOL FILTERS. Herrmann, G. (Technischer Ueberwachungs-Verein eV, Hanover). pp 521-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Results of a survey are presented of methods for testing the separation efficiency of such filters. The possibility of direct mass determination by use of piezoelectric crystals is evaluated. (INIS)

Safety Engineering

Refer also to abstracts 40813 and 41489.

Vacuum Engineering

Refer also to abstract 40992.

40817 DEVELOPMENT OF MASTER INSTRUMENTS FOR MEASURING TOTAL AND PARTIAL PRESSURE IN HIGH AND ULTRAHIGH VACUUM REGIONS. Gulyaev, M. A.; Eryukhin, A. V. Meas. Tech. (USSR) (Engl. Transl.); 14: No. 11, 1662-9(Nov 1971).

Translated from Izmer. Tekh.; 14: No. 11, 29-33(Nov 1971).

A master instrument has been developed, investigated, and certified for reproducing the unit of pressure in total and partial absolute pressure range of 10^{-3}–10^{-11} Pa (total pressure) and 10^{-3}–10^{-6} Pa (partial pressure). The apparatus consists of the following master devices: the GRAD cryogenic master device of second class; OIM master ionization pressure gage of third class; the OGIP master device of third class for calibrating partial pressure gages; and the ORU-2 master pressure reduction device of the second class. The characteristics of the instruments are given. The limiting pressure obtained with the GRAD cryostatic device is 3 to 4 × 10^{-11} Pa; it is the lowest pressure ever obtained in a device of this type. (auth)

ENVIRONMENTAL AND EARTH SCIENCES

Minerals and Ores

40818 ARLIT URANIUM MINE (REPUBLIC OF NIGER). Beulaygue, M. Ann. Mines; No. 3, 29-42(Mar 1972). (In French).

The Air Mineral Society (SOMAIR) associating the Republic of Niger with French, German, and Italian capital has been producing sodium uranate at a rate representative of 750 metric tons of uranium per year since the beginning of 1971. A two-fold increase in production is currently envisaged. The Arlit deposit, which is situated 2000 km from the sea consists of a 0.25% mineralized layer of clay and sandstone covered with 35 to 50 meters of overburden. The ore is obtained by open pit mining using explosives. After griding to 800 microns, the ore is treated with hot concentrated sulfuric acid solution. The sodium uranate has a titer between 68 and 71%. The investments made are high (approximately 230MF), most being concentrated in the processing factory. (France)

40819 URANIUM IN ACCESSORY APATITES. Berzina, I. G.; Eliseeva, O. P.; Stolyarova, A. N. Izv. Akad. Nauk SSSR, Ser. Geol.; No. 7, 79-86(Jul 1971). (In Russian).

Data are given on the content of uranium which has been introduced into apatite during its formation, and on the development of superimposed uranium, its distribution within the range of grains taken separately or in combination. The thermal stability of traces from uranium fission fragments in apatite crystals is discussed. The possibility of age determinations of minerals by the track method is discussed. (tr-auth)

40820 IODINE AND URANIUM IN SEDIMENTARY ROCKS. Becker, V. J.; Bennett, J. H.; Manuel, O. K. (Univ. of Missouri, Rolla). Chem. Geol.; 9: No. 2, 133-6(Apr 1972).

The abundance of iodine and uranium in sedimentary rocks was determined by neutron activation analyses. The iodine content is higher in the sediments than in igneous rocks and the iodine concentrations follow the same general pattern as chlorine and bromine in sedimentary rocks and deep-sea sediments. The uranium concentrations in these sediments are in good agreement with previous estimates, except for two uranium-rich sandstones. (auth)

40821 RADIOACTIVE SERIES DISEQUILIBRIUM IN URANIUM ECONOMIC GEOLOGY. Morgan, J. W. (Univ. of Chicago). At. Energy Aust.; 15: No. 2, 8-13(Apr 1972).

The principles of radioactive disequilibrium and techniques for its study are reviewed. The three naturally occurring decay chains are discussed and their application in terms of isotope ratios and element abundances to uranium distribution within an ore body is described. An outline is given of work directed towards a study of the fractionation of U series radioisotopes in well characterized geological environments. A method of exploration for economic uranium deposits which involves the determination of mobile U and its $^{234}U/^{238}U$ ratio on a transverse crossing the radioactive anomaly is briefly outlined. (Australia)

40822 WHEWELLITE FROM A URANIUM HYDROTHERMAL DEPOSIT. Chernykh, I. V.; Piloyan, G. O. (Inst. of the Geology of Ore Deposits, Petrography, Mineralogy, and Geochemistry, Moscow). Dokl. Akad. Nauk SSSR; 201: No. 6, 1449-52(21 Dec 1971). (In Russian).

Whewellite ($CaC_2O_4 \cdot H_2O$) was discovered at a depth of 320 m from the surface in a vein containing quartz, fluorite, and quartzite and in veins of uraninite and pyrite. Samples of the whewellite were subjected to chemical and thermogravimetric analyses. The latter technique demonstrated the stepwise loss of water and CO_2 to form the oxalate, carbonate, and oxide, respectively. (K.S.W.)

40823 CONTENT OF RADIOACTIVE ELEMENTS IN THE SODIUM METASOMATIC ROCKS. Sergeev, I. P.; Akvilev, A. A. Geol. Zh. (Russ. Ed.); 31: No. 6, 111-16(Nov 1971). (In Russian).

Uranium adaptations to sodium metasomatic rocks (albitic) were studied. These evolved along ancient, deep fractures in a cataclastic zone, with subsequent distribution of radioactive elements in the rocks which were dissected with deep crevices. Diagrams and tables aid in characterizing the radioactive elements and average compositions at different zones of the sodium "metasomatosis." At the beginning of sodium metasomatosis, U and Th were deposited from solutions in ever-growing quantities. Ultimately, Th remained in solution and U continued to accumulate wherever localization was favorable. (tr-auth)

40824 RADIO ASSAY OF LOW-GRADE U/Th ORES IN ppm RANGE. Singh, J. P.; Rai, Lajpat; Bhatnagar, A. S. (Dept. of Atomic Energy, New Delhi). pp 631-9 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

A beta-gamma method for the assay of low grade U ores suffers from the limitation that it does not yield accurate values of U, when potassium is present in appreciable quantities. Also, it does not reveal the presence of thorium if any. So, when both thorium and potassium are present in low grade U ores, determination of U is carried out by using a high sensitivity gamma ray spectrometer employing a special shield and using 600 gms of the sample in an annular geometry. Spectra of thin, intermediate and thick uranium samples are presented. The determination of U, Th, Ra, and K is done by measuring their characteristic contributions at 0.09 MeV, 0.24, 0.35 MeV, and 1.46 MeV gamma energies. Sensitivity of 1 ± 0.05 ppM in eU_3O_8 determination in 15 minutes and 1 ± 0.12 ppM of ThO_2 determination in thoriferous samples in 1 hour counting time was achieved. (auth)

Radioactive Effluents

Refer also to abstracts 40725 and 42546.

40825 (BNWL-1659) SCAVENGING OF GASEOUS TRITIUM COMPOUNDS BY RAIN. Hales, J. M. (Battelle Pacific Northwest Labs., Richland, Wash.). Apr 1972. Contract AT(45-1)-1830. 35p. Dep. NTIS.

Washout of gaseous tritium compounds from the atmosphere has been investigated theoretically. This analysis is based upon reversible gas-washout theory, and accounts for such factors as desorption and the influence of liquid-phase transport. General equations are presented which describe pollutant concentrations in single drops as they fall through the atmosphere. Results from these equations may be combined to provide total washout characteristics for natural rain by simple distribution over the drop-size spectra. These general equations are based upon the assumptions of vertical rainfall, spherical noninteracting drops, and linearity of the mass-transport processes, as well as several other less serious stipulations. They should be applicable for washout of all gases depending upon their deviations from this idealized behavior. The compounds of primary interest to this investigation (HT, T_2, HTO, and T_2O) should satisfy most of these requirements well; satisfaction of others, of course, will depend to a large extent on meteorological conditions. Sample calculations are presented for a specific rain situation in conjunction with bivariate, normally-distributed plumes containing HT and HTO. Major conclusions from these calculations are given as follows: HTO is washed out much more rapidly than HT, this arising from the low solubility of the latter; stack height plays a rather prominent role in affecting washout, especially at distances close to the source; and fog formation may be important in affecting HTO washout, but it should be an insignificant influence so far as HT is concerned. No data exist for HT or HTO washout which can be used to test these results. Data from experiments with other gases, however, tend to verify this approach, which is recommended as a method for use in estimating washout and dose rates for nuclear plant siting analyses and related considerations. (auth)

Radioactivity Transport and Monitoring

Refer also to abstract 41497.

40826 EVOLUTION OF OPPOSITION TO THE PEACEFUL USES OF NUCLEAR ENERGY. Smith, L. D. Nucl. Eng. Int.; 17: No. 193, 461-8(Jun 1972).

A detailed review is presented of the origins and increase of the opposition to nuclear power in the U.S.A., because of environmental considerations, and of the recent spread of opposition to other countries in Europe and Japan. (UK)

40827 SURVEY OF FALLOUT ^{90}Sr DATA FOR ASSESSMENT OF THE RADIOLOGICAL HAZARD. Lalit, B. Y. (Bhabha Atomic Research Centre, Trombay, India). pp 445-52 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

The levels of ^{90}Sr in some environmental samples from Bombay, New York, United Kingdom, and Australia were examined in relation to fission energy released as global fallout in the past. About 37 megatons equivalent of fission energy was released in the stratosphere from 1956 to 1958 whereas the energy released in 1961 to 1962 series was 101 megatons. Maximum levels of ^{90}Sr reached in various samples in 1959 to 1960 and 1962 to 1965 periods bear approximately the same ratio as fission energy released in the corresponding preceding year. Thus it is possible to predict the maximum levels of ^{90}Sr likely to be reached in the event of future test series in northern hemisphere if fission energy release in stratosphere is known, and hence the radiological hazard can be evaluated. (auth)

40828 RADIOACTIVITY MEASUREMENT AT TARAPUR NUCLEAR POWER STATION ENVIRONMENT. Bhat, I. S.; Khan, A. A.; Chandramouli, S. (TAPS Colony, Boisar, India). pp 493-505 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

The Environmental Survey Laboratory at Tarapur has carried out four years of preoperational investigations on enviromental radioactivity at the Tarapur site. In February 1969 the power reactors were put into operation and the station has been releasing low levels of radioactive liquid and gaseous effluents to the environment. The laboratory has been monitoring the increase in the radioactivity of the environment due to these discharges. The levels of radioactivation products and fission products in samples collected from land, air, and sea in the Tarapur environment and their comparison with maximum permissible levels are presented. (auth)

Atmosphere

40829 (AEC-tr-7308) STUDY OF THE ARTIFICIAL RADIOACTIVITY OF THE ATMOSPHERE AND ESPECIALLY OF THE CLOUDS. Danali, Susan D. Translated by Maria Sideris Oakberg (TTT), from a Greek Thesis. 67p. Dep. NTIS.

The artificial radioactivity of the atmosphere, especially of cumulus clouds moving horizontally and touching the peaks of Mt. Olympus, was measured during the period from 1965 to 1970 at the Olympus Scientific Center. Information is presented on the sampling and counting equipment and methods and data measured during July, August, and September for each of the five years. The effects of worldwide nuclear testing on the atmospheric radioactivity in Greece were evaluated. It was concluded that: the concentration of artificial radioactivity is higher inside cumulus clouds than outside and increases with increasing cloud elevation, at least to the 3000 m elevation of the Mt. Olympus summit; radioactive material from nuclear tests in Central Asia arrives in Greece after approximately two weeks; and fallout from nuclear tests made during the summer months in the Southern Hemisphere may also be carried to Greece. (L.C.L.)

40830 (AWTSC-3) FALLOUT OVER AUSTRALIA FROM NUCLEAR WEAPONS TESTED BY FRANCE IN POLYNESIA FROM JUNE TO AUGUST 1971. (Atomic Weapons Tests Safety Committee, Victoria (Australia)). Dec 1971. 28p. Dep. NTIS (U. S. Sales Only).

Measurements are reported on the fallout of fresh fission products in Australia from June to November, 1971, following nuclear weapons tests by France in Polynesia. The measurements were made at 26 stations to determine whole-body radiation doses and at nine major centers of population to establish average doses to thyroid. The data are summarized. The upper limits of the whole-body dose range from 0.1 to 2.2% of the average annual background radiation, and the thyroid doses range from 0.5 to 7.4% of the level considered acceptable by the National Radiation Advisory Committee. All of the radiation doses from fresh fallout in 1971 are small; they are lower than those for the series of nuclear weapons tests in Polynesia in 1966 and comparable to those for 1968 and 1970. The National Radiation Advisory Committee considers that radiation doses of this magnitude are of no significance as a hazard to health. (auth) (Australia)

40831 URANIUM AND THORIUM CONCENTRATIONS IN WIND-BORNE SAHARAN DUST OVER THE WESTERN EQUATORIAL NORTH ATLANTIC OCEAN. Rydell, Harold S.; Prospero, Joseph M. (Univ. of Miami, Fla.). Earth Planet. Sci. Lett.; 14: No. 3, 397-402(Apr 1972).

The average uranium and thorium concentration in 15 samples of wind-borne Saharan dust collected at Barbados, West Indies, is 3.6 and 12.4 ppM, respectively; these values are approximately one-third greater than that of average crustal material. The thorium–uranium weight ratio of the dust is 3.5, about the same as that of the crust; the ^{234}U/^{238}U activity ratio is 1.08 and the ^{230}Th/^{234}U activity ratio, 0.97. It is concluded that the presence of large amounts of African dust in Atlantic sediments would not significantly affect the validity of the assumptions inherent in the ^{231}Pa/^{230}Th and ^{230}Th/^{232}Th dating methods. (auth)

40832 STEADY-STATE VERTICAL TURBULENT DIFFUSION OF RADON. Cohen, L. D.; Barr, S.; Krablin, R.; Newstein, H. (Drexel Univ., Philadelphia). J. Geophys. Res.; 77: No. 15, 2654-68(20 May 1972).

Hourly average radon-gas concentrations were measured at elevations of 6.1, 61, 174, and 271 meters on a continuous basis for over 1 year. A search through 5 months of data revealed 383 hours of data that satisfy a steady-state criteria. The steady-state radon profiles correlate with atmospheric stability through a stability ratio and are naturally divided into four categories. The turbulent transfer is parameterized in terms of a radon diffusivity K that is related to general meteorological conditions. An independent specification of K is made based on dimensional reasoning and empirical turbulence statistics in an extension of work by Hanna (1968). A two-layer domain for diffusivity is used in a computational model in which the upper-layer K is independent of height but varies with meteorological conditions; and in the surface layer below 100 meters K is given as $K(Z) = K(Z_0)\ (Z/Z_0)^{\alpha}$. (auth)

40833 RELATIVE CONCENTRATIONS OF ^{222}Rn DAUGHTER IONS IN AIR. Jonassen, Niels; Hayes, Edward (Technical Univ. of Denmark, Lyngby). J. Geophys. Res.; 77: No. 15, 2648-53(20 May 1972).

The short-lived daughters of radon-222 existing as ions in laboratory air are deposited by an electric field on a foil acting as the central electrode in a cylindrical capacitor. The experiments show that the time dependence of the alpha activity from ^{214}Po, which is determined by the relative concentrations of the daughter ions in the air, depends on the critical mobility used in the collecting system. For high critical mobilities ($k_c > 10^{-5}$ m^2 v^{-1} sec^{-1}) one characteristic decay curve was always obtained, indicating relative concentrations of ^{218}Po, ^{214}Pb, and ^{214}Bi ions in the ratio 1 : 1.5 : 0.2. Experiments with critical mobilities about 10^{-6} m^2 v^{-1} sec^{-1} gave a second characteristic decay curve, indicating relative concentrations of ^{218}Po, ^{214}Pb, and ^{214}Bi ions in the ratio 1 : 4 : 5.4. (auth)

40834 BEHAVIOR AND SIZE DISTRIBUTION OF NATURAL RADIOACTIVE IONS. Havlovic, Vratislav; Snihs, Jan Olof (National Inst. of Radiation Protection, Stockholm). Arch. Environ. Health; 24: No. 6, 432-43(Jun 1972).

The existence, qualitative constitution, and mobility distribution of short-lived decay products of radon in the form of positive small ions were investigated using a mobility analyzer. The activity was analyzed by α-spectroscopy. The decay curves of the activity corresponding to different critical mobilities were compared with the theoretical decay curves of short-lived decay products of radon. The small radioactive ions with critical mobilities about $k_c = 0.133$ cm sq · sec^{-1} · volt^{-1} are carrying RaA : RaB : RaC in radioactive equilibrium, while ions with critical mobilities about $k_c = 3.98$ cm sq · sec^{-1} · volt^{-1} are carrying presumably RaA. It seems that there is no strict limit between those two extreme cases. (auth)

40835 SHAPE FACTORS FOR AEROSOLS OF COAL, QUARTZ, UO_2 AND ThO_2 IN RESPIRABLE SIZE RANGE. Kotrappa, Payasada. Rochester, N. Y.; Univ. of Rochester (1971). 152p. University Microfilms Order No. 72-14,698.

Thesis.

The physical and aerodynamic properties of irregular shaped particles and their interrelations are of importance in interpreting inhalation experiments and also in basic aerosol science. Shape factors are the numerical coefficients which relate such properties to the projected area diameter which is the most often measured characteristic of an aerosol. A recently developed spinning spiral type aerosol spectrometer was used to obtain aerodynamically size-graded samples in about 25 narrow size groups within the respirable size range of 0.4 μm to 4.0 μm (aerodynamic diameter) for a low grade coal, pulverized UO_2, homogenized and dried ThO_2, and ground quartz, all of which have been employed for inhalation studies at the University of Rochester. These materials were aerosolized by a Wright Dust Feed. Mass measurements were done by the assay of alpha activity for UO_2 and ThO_2, by a radioactive tracer technique for coal and by a microchemical analysis for quartz. Projected area diameters (D_p) were determined by electron microscopy and the surface areas by the BET method. Scanning electron microscopy was used for understanding the physical structure. Volume shape factors, dynamic shape factors, ratio of D_p to D_{st} (Stokes diameter) and projected area resistance shape factors were determined as a function of the D_p. Surface shape factors averaged over the entire size range studied were also determined. Geometric standard deviation (σg) for D_p for a given D_{st} was also computed for each size group. The overall number and mass distributions were determined. It was noted that an experimentally determined MMD (mass median diameter) agreed fairly well with the MMD calculated by employing Hatch and Choate equation using experimentally determined number distributions. A good correlation between the mass of a particle and the cube of D_p indicated a fairly constant volume shape factor and the particle density over the entire size range studied. At smaller sizes, aerosols of UO_2, ThO_2 and quartz tended to behave aerodynamically more spherical, whereas no such behavior was noted for coal. It was shown that using D_p/D_{st} values obtained in the studies, calibration curves for two stage air samplers originally determined by using uranium oxide aerosols could be revised, bringing them into a better agreement with the curves recently obtained by using spherical monodisperse latex aerosols. It was also noted that a single reasonable spheroid model with a particular axial ratio could not be found to satisfy shape factors obtained in this study. Examination of shadowed electron micrographs at various sizes appeared to indicate random deposition orientation. Procedures adopted were used to demonstrate that useful studies of this type can be done on aerosols in the respirable size range. Measurement of D_{st} of an aerosol characterized in terms of shape factors can provide all the aerosol properties of interest. (Diss. Abstr. Int., B)

40836 BULK DIFFUSION COEFFICIENT AND THERMAL DIFFUSION FACTOR IN RADON AND HELIUM FROM 300 TO 750°K. Lindquist, Kenneth Ogden. University Park, Pa.; Pennsylvania State Univ. (1971). 130p. University Microfilms Order No. 72-13,888.

Thesis.

The transport properties of gases have received considerable attention in this century. Since the Chapman–Enskog kinetic theory of gases applies rigorously only to monatomic gases, the rare gases, with the exception of radon, have received particular attention. There are no stable isotopes of radon; and, consequently, there are limited amounts of this gas available for transport studies. A new method is described which permits the experimental measurement of the bulk diffusion coefficient (BDC) and the thermal diffusion factor (TDF) in binary gas mixtures containing radon-220 (thoron) at infinite dilution. Thoron, produced by a thorium-228 emanation source, is introduced at the closed-end of a long narrow diffusion tube initially filled with helium. Thoron diffuses through the gas-filled tube, and the thoron number flux at the open-end of the diffusion tube is measured. The gas in the diffusion tube can be maintained at both uniform and non-uniform temperatures, from ambient to 600°C. The BDC is determined by comparing the time-dependent thoron flux at the open-end of the diffusion tube with a mathematical model which describes thoron diffusion at uniform temperatures. Similarly, the TDF is determined from measurements of the steady state thoron flux and a diffusion model that describes the diffusion of thoron in a temperature gradient. The apparatus is designed so that thoron diffusion is essentially one-dimensional, and the mathematical models are based on solutions of the one-dimensional diffusion equation with boundary conditions appropriate to the apparatus. The method was used to measure the BDC and TDF as a function of temperature from 295 to 750°K in a mixture of thoron and helium. The temperature dependence of these transport coefficients is satisfactorily described by the Lennard–Jones (12-6) potential function. Resolution of the data yields a set of radon–helium and radon–radon force constants. Comparison of the data in this study with published data for other rare gas mixtures shows that the precision of this method is comparable to the best obtained with conventional methods and suggests that it is more suitable for thermal diffusion measurements in mixtures containing radon. (Diss. Abstr. Int., B)

40837 MONTHLY DEPOSITION OF ^{137}Cs IN THE PERIOD FROM 1964 THROUGH 1971 AT OSAKA, JAPAN. Matsunami, T.; Mizohata, A.; Fujita, A.; Mamuro, T. (Radiation Center of Osaka Prefecture, Sakai, Japan). J. Radiat. Res.; 13: No. 2, 91-4(Jun 1972).

Monthly deposition of ^{137}Cs at Osaka was measured in the period from July 1964 through July 1971. Gamma-ray spectra of the samples collected monthly by the basin method were measured using a large volume Ge(Li) detector shielded with 20 cm iron in order to determine their ^{137}Cs activities. On close examination of the variation of monthly ^{137}Cs deposition, it is noted that, besides the seasonal variation of so-called spring maximum, there appeared many peaks, each of which can be assumed to have been caused by the influence of a nuclear explosion. Yearly ^{137}Cs depositions during the period were also estimated and compared with those measured by another institute. (auth)

40838 RADIOACTIVE FALLOUT ON GREENLAND AND THE FAEROE ISLANDS IN 1966, 1967, 1968. AND 1969. Fra Sundhedsstyr.; 5: 323-4(Apr 1971). (In Danish).

The results of fallout monitoring at the Faeroe Islands and Greenland during 1966 to 1970 are presented. Tabulated data are included on the ^{90}Sr content in ground-level atmosphere at various locations in Greenland and the ^{137}Cs and ^{90}Sr contents in foodstuffs in Greenland and the Faeroe Islands. (L.C.L.)

40839 SIZE SPECTRUM OF PLUTONIUM AEROSOLS: PARAMETER FOR EVALUATION OF INHALATION HAZARD. Kelkar, D. N.; Joshi, P. V. (Bhabba Atomic Research Centre, Trombay, India). pp 417-25 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

In cases of air contamination involving highly radiotoxic substances such as ^{239}Pu, knowledge of the size distribution of aerosols is necessary in addition to concentration measurements, for evaluation of lung exposures. Results of such measurements done in a plutonium laboratory are presented here. The plutonium aerosol studied shows an activity median diameter of 1.1 μm with a geometric standard deviation of 1.3. Analysis of individual samples shows that the distribution remains unchanged with time. Results of the calculations of radioactivity retention by lungs for different size distributions, based on the current lung model, are presented to show the effect of this parameter on the exposure evaluation. (auth)

40840 EVALUATION OF ATMOSPHERIC RADON AROUND THE URANIUM COMPLEX AT JADUGUDA. Khan, A. H.; Giridhar, Jha (Bhabha Atomic Research Centre, Trombay, India). pp 487-91 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

A brief account of surveys conducted from time to time to evaluate the atmospheric radon concentration at Jaduguda during the period from 1965 to 1970 is presented. The probable sources of atmospheric radon are described. Data obtained are presented and their significance discussed. Available data on atmospheric radon in Trombay and Alwaye are compared. (auth)

40841 AIRBORNE RADIOACTIVITY AT SINDRI. Srivastava, S. C.; Khalsa, S. P. S.; Das, S. K.; Banerji, K. C. (Fertilizer Corp. of India Ltd., Sindri). pp 513-20 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

Airborne radioactivity and general gamma-background were measured and reported for various locations at Sindri around the Radioisotope Laboratory and Gamma Garden for the period February to August 1970. The concentration of atmospheric radon and thoron decay products, such as Ra (B & C) and Thb, was determined at 22 different locations. The contribution due to fallout particles from nuclear detonations was assessed. The general gamma-background of the locality is reported in terms of radiation dose-rate corresponding to ^{60}Co gamma rays. (auth)

40842 LEVELS AND VARIATIONS OF ATMOSPHERIC RADIOACTIVITY IN SURFACE AIR. Gopalakrishnan, Smt, S. (Bhabha Atomic Research Centre, Trombay, India). pp 521-32 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

Atmospheric concentrations of various types of radioactivity in the Indian environment are presented and the causes of their variation discussed. It is shown by measurements over several years that stratospheric sources like fission products such as ^{137}Cs follow a spring cycle with peak values in March and April. The cosmic-ray produced ^{7}Be while undergoing a seasonal variation similar to that of ^{137}Cs, exhibits two components, a seasonally varying stratospheric component superimposed on a constant tropospheric component. Short lived radon daughters follow a seasonal variation with peak concentrations in winter (December and January). From the close similarity of ^{210}Pb with short lived radon daughters, it is concluded that ^{210}Pb is predominantly of local origin. The latitudinal dependence of the various sources of radioactivity is also discussed. (auth)

40843 DATA. SECTION III. AIR AND DEPOSITION. Radiat. Data Rep.; 13: No. 4, 281-93(May 1972).

January 1972 measurements of the gross beta activity in surface air and atmospheric precipitation at 70 stations in the USA and 24 stations in Canada and in surface air only at 12 South American and 14 California stations are reported. The gross beta activity in airborne particulates sampled at 6 Mexican stations during Feb. through Dec. 1971 is tabulated. Data on the gross beta activity in surface air sampled at 104 stations in 21 western states of the US during Dec. 1971 and Jan. 1972 are presented. (L.C.L.)

40844 OTHER DATA. SECTION IV. OTHER DATA. Radiat. Data Rep.; 13: No. 4, 294-320(May 1972).

Data from routine sampling of biological materials and other media are reported. Off-site surveillance activities around the Nevada Test Site (NTS) during Jan. to July 1967 are described. The effects on environmental radioactivity of events conducted at the NTS, i.e., the underground nuclear tests Nash on Jan. 19, 1967 and Umber on June 29, 1967 and Phoebus IB-III and -IV reactor tests on Feb. 10 and 24, 1967, are evaluated from monitoring of the gross beta activity in ground-level air and the ^{131}I content in milk. Data on the ^{90}Sr content in human bone sampled from the US population during April to July 1971 are tabulated. Environmental radioactivity data for the Argonne National Laboratory site during Jan. to July 1971 and the Brookhaven National Laboratory during July through Dec. 1967 are presented. One nuclear detonation in the US during April 1972 is reported. (L.C.L.)

40845 OBSERVATION OF MONTHLY DEPOSITION OF ^{137}Cs IN THE PERIOD FROM 1964 THROUGH 1971. Matsunami, Tadao; Mizohata, Akira; Fujita, Akira; Mamuro, Tetsuo. Annu. Rep. Radiat. Center Osaka Prefect.; 12: 15-17(1971).

The monthly deposition of ^{137}Cs at Osaka, Japan was observed in the period of 7 years from July 1964 through July 1971. Gamma-ray spectra of the samples collected monthly by the basin method were measured with a large volume Ge(Li) detector shielded with 20 cm of iron in order to determine ^{137}Cs activities. On close examination of the variation of monthly ^{137}Cs deposition, it is clearly seen that, besides the seasonal variation showing the characteristic feature of so-called "spring maximum", there appeared many peaks, each of which can be assumed to have been caused by the influence of a corresponding nuclear explosion. Yearly ^{137}Cs depositions were also estimated on the basis of the present observation, and compared with those measured by other institutes. (auth)

40846 OBSERVATION OF RADIORUTHENIUM AND RADIOCERIUM ISOTOPIC ACTIVITY RATIOS IN RAIN WATER. Mamuro, Tetsuo; Matsunami, Tadao; Mizohata, Akira. Annu. Rep. Radiat. Center Osaka Prefect.; 12: 13-14(1971).

It has been predicted on the basis of the results of observations carried out during 1970, that the nuclear debris injected into the stratosphere by the Chinese nuclear explosion of October 14, 1970 would become noticeable in rainwater abruptly in the first months of 1971 and thus high values of the radioruthenium and radiocerium isotopic activity ratios would be observed again. It was confirmed that the isotopic activity ratios increased abruptly in February 1971 and thus the prediction was realized. The influence of the nuclear debris released from venting from an underground explosion carried out at Nevada on December 18, 1970 was also clearly detected in our observation. (auth)

Soil

40847 (INR-1392) RADIOACTIVE CONTAMINATIONS OF THE INSTITUTE OF NUCLEAR RESEARCH, CENTRE ZERAN SITE AND ENVIRONS IN 1970. Stpiczynska, Zofia; Jaskulski, Jan (Institute of Nuclear Research, Warsaw (Poland)). 1972. 17p. (In Polish). Dep. NTIS (U. S. Sales Only).

Radioactivity measurements at the Institute of Nuclear Research–Zeran Center site and its environs carried out in 1970 are reported. This work is the continuation of the investigations started in 1957 and carried out for watching the eventual influence of the Institute work on the environs radioactivity. The radioactivity of fallout, soil, grass, rye, waters and wastes considered as typical materials of the Center environs was measured. (auth)

40848 FALLOUT RADIOACTIVITY IN INDIAN SOILS. Mishra, U. C.; Sadasivan, S. (Bhabha Atomic Research Centre, Bombay). Health Phys.; 23: No. 1, 55-62(Jul 1972).

Results of gamma spectrometric measurements of ^{144}Ce, ^{106}Ru, ^{125}Sb and ^{137}Cs activities of fallout origin in samples of Indian soils are reported. The samples were collected during 1966–1970 from a number of places in India. Some of the samples were analyzed for ^{90}Sr by conventional chemical methods and beta counting, and the ratios ^{137}Cs/^{90}Sr were studied. The results were compared with global ^{90}Sr soil measurements and the important differences are brought out. The variations of concentrations with depth, rainfall, latitude, etc. are discussed. The external gamma dose rates due to fallout gamma emitters in soils were computed and compared with estimated dose rates due to natural radioactivity. (auth)

40849 DISTRIBUTION OF ^{226}Ra IN SOIL AND WATER. Rao, S. R.; Borkar, M. D.; Shah, S. N. (Bhabha Atomic Research Centre, Trombay, India). pp 507-12 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

Soil and water samples were collected from different locations and analyzed for ^{226}Ra content, which forms a significant part of our environmental alpha activity. The results obtained for various locations are compared and discussed. (auth)

40850 RADON AND THORON EXHALATION FROM THE GROUND. Megumi, Kazuko; Mamuro, Tetsuo. Annu. Rep. Radiat. Center Osaka Prefect.; 12: 18-21(1971).

Radon and thoron gases released from the ground were directly adsorbed on granular activated charcoal and the charcoal was subjected to γ-ray spectrometry. It was observed that the radon exhalation remained low for several days after a heavy rainfall but did not appreciably change after a light rainfall. On the other hand, although the thoron exhalation was low after a rainfall regardless of the amount of rainfall, it was found that the thoron exhalation depends strongly on the moisture of the surface soil. The measured values of the exhalation rates were compared with the values estimated from the contents of uranium and thorium in the soil according to the model given by Israel; agreement was good for the radon exhalation; however, the measured values of the thoron exhalation rate were around three times as large as the estimated values. (auth)

Water

40851 (NVO-1229-179) HYDRODYNAMIC TRANSPORT OF RADIONUCLIDES: ONE-DIMENSIONAL CASE WITH TWO-DIMENSIONAL APPROXIMATION. Holly, D. E.; Guinasso, N. L. Jr.; Essington, E. H. (Nevada Operations Office (AEC), Las Vegas). Sep 1971. Contract AT(29-2)-1229. 106p. Dep. NTIS.

One-dimensional mathematical models of the transport and hydrodynamic dispersion of radionuclides in granular media are described. The mathematical formulation consists of the derivation of the transport equations and definition of sundry boundary conditions. The transport equation is reduced to the heat equation by a suitable change of variables and the solution of the resulting transformed boundary value problem. Analytical solutions are given for four sets of boundary conditions and the results are discussed. The analytical solution is limited to a homogeneous aquifer. A method is presented to obtain an approximate two-dimensional solution as a product of the longitudinal transport solution and the lateral dispersion solution for each of the four boundary conditions. Another method to approximate the two-dimensional solution represents the initial concentration field as a series of cells, calculates the position of each cell as a function of time by moving them on groundwater flow trajectories, and calculates the concentration field by summing the contributions from each cell. Computer programs to evaluate each of the solutions are presented in Appendices together with sample outputs and sufficient information to enable the reader to use them. (auth)

40852 RADIORUTHENIUM IN AQUATIC ENVIRONMENT OF TROMBAY. Dey, N. N.; Pillai, K. C. (Bhabha Atomic Research Centre, Trombay, India). pp 541-53 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

Subsequent to the appearance of radioactivity above background levels in some wells located near the fuel reprocessing plant at Trombay, detailed studies were undertaken to identify and measure the concentration of radionuclides in the well waters. The measurement of total beta, radioruthenium, ^{90}Sr and ^{137}Cs concentrations indicated that radioruthenium is the most predominant radionuclide in well waters. The nature of radioruthenium in well waters was investigated. Measurements made during the last 30 months showed seasonal variations in the activity levels. Radioruthenium measurements in seawater, silt, and bottom sediments in the Bombay Harbor Bay indicated low levels in seawater and high concentration in sediments. The radioruthenium in sediments was limited to the discharge locale. Levels were low compared to ^{137}Cs. Some benthic organisms collected in the bay from areas close to the effluent discharge locations showed high concentration factors for radioruthenium. (auth)

40853 DATA. SECTION II. WATER. Radiat. Data Rep.; 13: No. 4, 267-80(May 1972).

Water sampling and monitoring programs in the US are described. Tabulated data are presented on: gross alpha and beta activity in US surface waters sampled during Sept. 1971 and Apr.

through June 1971; gross beta activity in N. Y. state surface waters sampled during July 1970 to July 1971; ^{90}Sr and tritium content in N. Y. state surface waters sampled during July 1970 to July 1971; gross alpha and beta activity and ^{226}Ra content in US interstate carrier water supplies sampled during 1971; and tritium content in US drinking and surface water sampled during Oct. through Dec. 1971. (L.C.L.)

Ecosystems and Food Cycles

Refer also to abstracts 41235, 41236, 41265, and 41267.

40854 (ORO-490-22) RADIOACTIVITY TRANSPORT IN WATER: BIOLOGICAL ACCUMULATION OF MERCURIC AND METHYL MERCURY BY CHLORELLA PYRENOIDOSA. Matsui, Saburo; Gloyna, Earnest F. (Texas Univ., Austin. Center for Research in Water Resources). Apr 1972. Contract AT(11-1)-490. 251p. Dep. NTIS.

The findings of high levels of mercury in marine and fresh water fish, and associated Minamata disease, have initiated studies to evaluate the complex behavior of mercury in ecosystems. A primary objective of this study was to evaluate the influence of various environmental factors on the accumulation and desorption of mercurials by the fresh water alga Chlorella pyrenoidosa. Radioactive isotopes of mercury in the form of mercuric mercury and methyl mercury were used. The study has resulted in two principal findings. First, it was determined that a sorption isotherm can be used to evaluate the toxic effect of waste releases containing mercury on phytoplankton, especially Chlorella pyrenoidosa, and the influence of algal biomass on the transport of mercurials through the food chain. Second, it was found that three types of mass transfer models can be used to describe the kinetics of sorption and desorption. These models employ a uniform function, an exponential function, and a power function. Using these models, sorptions and desorptions of mercuric mercury and methyl mercury are described respectively by the uniform function model and the exponential function model. (auth)

40855 APPLICATION OF MULTIPLE REGRESSION TO THE STUDY OF RADIOACTIVE CONTAMINATION. Orlando, G.; Balestra, V. (Univ., Genoa). G. Ig. Med. Prev.; 10: 41-53(Jan-Mar 1969). (In Italian).

The ^{90}Sr content in cow's milk from 9 Italian towns during the period Nov. 1961 to Dec. 1964, were measured and related to the amounts of ^{137}Cs, Ca, and K in the same milk. By means of multiple regression analysis it was established that, for a theoretical prediction of the ^{90}Sr, the most valuable information is given by ^{137}Cs: the importance of Ca is much smaller, K is practically negligible. The variability of the ^{90}Sr values calculated by means of the equation of multiple regression, and compared with the observed values, resulted in an average of nearly 24% for the range of the Sr values above 20. Within that extent, the variability appears to be sufficiently proportional to the absolute value observed for the ^{90}Sr. (auth)

40856 MEASUREMENT OF RADIUM CONTENTS OF INDIAN TOBACCO AND CIGARETTES. Chatterjee, Ramkrishna; Banerji, Partha (Chittaranjan National Cancer Research Centre, Calcutta). pp 465-71 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

A brief account of the measurement of the radium contents of Indian tobacco and popular local brands of cigarettes is given. A comparative study with the radium contents of foreign brands is also made. It is found that the value of radium content of Indian pipe tobacco (0.17 pCi/g) is of the same order as that of raw tobacco of many European countries. However, the radium content of Indian cigarettes is usually lower than of its Australian counterpart. The radium content of Indian variety "Biri" is the lowest of those studied. (auth)

40857 MONITORING OF THE AQUATIC ENVIRONMENT IN THE NEIGHBORHOOD OF URANIUM MILL AT JADUGUDA, BIHAR. Iyengar, M. A. R.; Markose, P. M. (Bhabha Atomic Research Centre, Trombay, India). pp 473-85 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

The results of a survey of the water environment in the vicinity of the Uranium Corporation of India Ltd., Jaduguda, Bihar are presented. The uranium ore processing method and the tailings disposal method are briefly described. The follow-up data gathered over the last 3 years of some of the radionuclides of the uranium series in different media like river water, well water, bottom mud, algae, fish etc., following the tailings pond effluent discharge into surface waters are presented and their significance discussed. The utility of bottom sediment monitoring and algae and fish analysis as cumulative indicators of polluted stream are presented. (auth)

40858 CONCENTRATION FACTORS IN THE AQUATIC ENVIRONMENT. Jinks, S. M.; Eisenbud, M. (New York Univ., N. Y.). Radiat. Data Rep.; 13: No. 4, 243-7(May 1972).

Concentration factors for various freshwater and marine organisms as gathered from the literature are presented. The concentration factor is defined as the concentration of a given radioisotope or stable element in the organism divided by the concentration of the radioisotope or stable element in the ambient water. Attention is called to the existence of considerable variability in the reported values, and the reasons for this variability are briefly discussed. In addition to the difference in concentration factors for the marine and freshwater environments and because of differences in concentrations of stable elements in the two systems, other sources of variability include errors in sampling and analysis, physiological factors, and ecological disequilibria. (L.C.L.)

40859 DATA. SECTION I. MILK AND FOOD. Radiat. Data Rep.; 13: No. 4, 255-66(May 1972).

January 1972 measurements of the radioisotope content of milk samples at 61 stations in the US, 5 stations in Central and South America, and 16 stations in Canada are reported as tabulated data on the ^{137}Cs and ^{90}Sr content plus limited data on the ^{89}Sr and ^{131}I content of samples at 11 US stations. The ^{14}C content in total diet and milk sampled at 9 US stations during the last half of 1971 is reported. (L.C.L.)

40860 DATA. SECTION IV. OTHER DATA. Radiat. Data Rep.; 13: No. 4, 227-41(Apr 1972).

Data are presented on offsite surveillance around the Nevada Test Site July through Dec. 1966, including K, ^{90}Sr, ^{137}Cs, ^{89}Sr, ^{131}I, ^{103}Ru, and ^{140}Ba in milk and environmental levels of radioactivity at Atomic Energy Commission installations, including Neutron Devices Dept. of G. E., St. Petersburg, Fla., for July through Dec. 1970, Paducah Plant for July through Dec. 1970. The results on the Nevada Test Site indicate that no individual in the offsite area received an exposure resulting from operations, which exceeded the guides established by the AEC and/or recommended by the FRC and the NCRP. Offsite radioactivity concentrations encountered by the general population at G. E. were found to be substantially lower than the AEC standards for continuous nonoccupational exposure. External γ radiation in the vicinity of the Paducah Plant averaged 0.02 mR/h at all sampling stations for July through Dec. 1970, except for the east plant perimeter station which had an average of 0.03 mR/h. The average U concentration in air at the perimeter fence was 1% of the AEC standards for people residing in the vicinity of a controlled area. (P.C.H.)

Radiometric Techniques

Refer also to abstracts 40785, 40824, and 40937.

40861 (IFA-MR-36) RADIOACTIVE TRACERS FOR HYDROLOGICAL WORKS. Gaspar, E. (Institutul de Fizica Atomica, Bucharest (Romania)). 1971. 24p. Dep. NTIS (U. S. Sales Only).

The selection and uses of radioactive tracers for hydrologic investigations are reviewed. (L.C.L.)

40862 INFLUENCE OF EXPERIMENTAL FACTORS ON AGE RESULTS OBTAINED BY THE FISSION-TRACK DATING METHOD. Oncescu, M. (Inst. of Atomic Physics, Bucharest): Sandru, P.; Danis, Ana; Minzatu, Silvia. Rev. Roum. Phys.; 17: No. 1, 63-9(1972).

New experimental factors are revealed which lead to a modification of track densities due to fragments from neutron-induced fission, i.e., of the ratio ρ_s/Δ_ρ appearing in the relation which yields the age in the fission track dating method. These factors modify the etching process of the fission fragment tracks increasing the etching rate under the influence of irradiation itself as well as of the sample radioactivity. The influence of these factors is important the dating results being modified by more than 10%. It is therefore necessary to understand the nature of these factors and to minimize their influence if correct results are to be obtained, which could be taken as a basis in the geologic interpretation of dating results. (auth)

40863 VARIATIONS OF NATURAL RADIOCARBON DURING THE LAST 11 MILLENIA AND GEOPHYSICAL MECHANISMS FOR

PRODUCING THEM. Yang, Albert In Che. Seattle; Univ. of Washington (1971). 118p. University Microfilms Order No. 72-15,164.

Thesis.

Earlier work by Buddemeier, a radiocarbon study of the varved marine sediments of Saanich Inlet, British Columbia, has been extended to the bottom of the basin, which corresponds to a radiocarbon age of approximately 11,000 years ago. In addition, several tens of datable terrestrial material were also found embedded in the sediment. The carbon-14 activities of sedimentary organic carbon and terrestrial samples provide information on long-term carbon-14 variations in Saanich Inlet water and atmosphere, respectively. The measured carbon-14 variations in the atmosphere (terrestrial samples) agree well with the tree ring data over the past 6,100 years. Between 8,500 and 6,100 years before present (B.P.), the atmospheric carbon-14 activity increased from 60 to 100%. Prior to 8,500 years, it is predicted to continue its downward trend on the basis of Saanich Inlet water activity. On the other hand, the sediment (oceanic) carbon-14 variations have a similar trend as the atmosphere except the former has slightly lower amplitude and lags behind the latter several hundred years. Model calculation results suggest that the earth's geomagnetic dipole moment alone accounts fairly well for the observed amplitude of carbon-14 variations both in the atmosphere and in the ocean for the last 6,000 years. However, for the period between 6,000 and 11,000 years B.P., geomagnetic field changes alone can not explain the observed order of magnitude; climatic factors have to be taken into account to give a satisfactory explanation. Sensitivity of carbon-14 variations in the air reservoir to the assumed residence times of carbon-14 is only second order magnitude (compared with the geomagnetic effect). (Diss. Abstr. Int., B)

40864 DISTRIBUTION OF SPONTANEOUS FISSION NEUTRONS FROM URANIUM NUCLEI IN AN ORE BED CUT BY A CYLINDRICAL BOREHOLE. Davydov, Yu. B. This paper was summarized in At. Energ. (USSR); 30: No. 4, 386-7(Apr 1971) as paper No. 482/5859. (In Russian).

Full copy of this paper is held by TIC.

The cylindrically symmetrical boundary problem dealing with the distribution of neutrons emitted in spontaneous fission of uranium nuclei in a two-layer infinite medium, with a cylindrical interface, is solved. The internal medium simulates a borehole, the external medium the ore bed. This ore bed contains neutron sources with a one-dimensional distribution, varying in the direction of the borehole axis. The assumption is that the presence of such sources, i.e., the variation in the chemical composition of the bed, is without effect on the physical properties of the bed responsible for neutron transport (the bed constitutes a quasihomogeneous medium in this sense). The problem is solved in the two-group diffusion approximation. The solution in the general form is found by the method of integral transformation. The Green's function method is applied in order to find the concrete form of the solution. A formula is derived for the density of thermal neutrons and fast neutrons in the borehole–bed system, with an arbitrary pattern of source density variation. The solution of the boundary problem in the general form serves as the starting expression for a further detailed analysis of the fission-neutron distribution in the cases of greatest practical interest, which are realized in actuality. As an illustration, the fission-neutron distribution in a system comprising borehole and ore bed of finite thickness with uniform mineralization is considered. Numerical calculations were carried out for an ore stratum made up of porous limestone intersected by a borehole filled with fresh water. It is assumed, in these calculations, that the pores in the limestone become filled with fresh water. Analysis of the results of the calculations provides evidence that treatment of the effect of the borehole and intervening host rock can be handled independently in the first approximation, inasmuch as the functions determining the effects of these two factors appeared as cofactors in the final solution. The configuration of the neutron logging curves depends largely on the water content of the bed. Analysis of saturation curves revealed that, as the hydrogen content increased, saturation set in earlier, i.e., at a lower thickness of active ore stratum. It was also demonstrated that, as the radius of the borehole is increased, the fast-neutron density on the borehole axis declines, while a local density rise is observed in the case of thermal neutrons, up to radii of 4 to 6 cm. This is explained by the anomalously high absorption of fast neutrons by the hydrogeneous medium. (auth)

40865 NONDESTRUCTIVE ACTIVATION ANALYSIS OF ROCK SAMPLES FOR Cu CONTENTS USING Pu–Be NEUTRON SOURCE. Gurna, Sher Singh; Bhatnagar, A. S. (Dept. of Atomic Energy, New Delhi). pp 615-22 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

Using a low level neutron source and two single channel analyzers coupled to NaI(Tl) detector, it was possible to determine the copper content of the ore sample up to a lower limit of 0.06% Cu. Samples were chosen from two distant areas i.e., Singhbhum in Bihar and Khetri in Rajasthan, to present two different matrices. Chemical separations were totally avoided. Interferences from matrix were minimized and unavoidable interferences identified and accounted for. The results obtained reveal the possibilities of quick and nondestructive analysis of Cu ores. Simultaneous estimation of Mn and Cu in Khetri samples and Na and Cu in Singhbhum samples are rendered possible by this method. The estimated values of Cu agree with chemical values within ±12%. Determination of Cu in samples having Cu contents above 0.37% and Na values not exceeding 3% can be made with an accuracy better than ±10%. (auth)

40866 GAMMA-IRRADIATION EFFECT ON ROCK CRYSTALS. Inagaki, Hirotake (Kyoto Univ.). Mem. Fac. Sci., Kyoto Univ., Ser. Geol. Mineral.; 38: No. 2, 209-17(Dec 1971).

Gamma irradiation effect on rock crystals from various geologic origins was studied. Gamma irradiation produced smoky color and sometimes citrine color in rock crystals, but a few rock crystals were not affected. The pattern of smoky coloration is classified into three types which are related to the geologic origin; 1. normal type, 2. lamellar type, 3. irregular type. The degree of blackening of rock crystals from pegmatite is roughly related to the temperature at which the crystal was formed, and the thermal history of the crystal can be well presumed. On absorption spectra of rock crystals, A_2 peak position is variable in 440-500 mμ range. Rock crystals with A_2 peak at about 440-460 mμ have high intensity in smoky color and mostly occur in pegmatite, whereas crystals with A_2 peak at about 500 mμ have low intensity in smoky color and mostly occur in hydrothermal vein. The wide variation (440-500 mμ) of A_2 peak position is thought to be caused by the difference of interstitial ion in Al defect. Citrine color has absorption peak at 390-410 mμ and is often coexistent with smoky color. Rock crystals with citrine color occur in hydrothermal vein or skarn. (auth) (Japan)

40867 ISOTOPIC DATING IN THE KAMATIVI TIN BELT, SOUTHERN RHODESIA. Priem, H. N. A.; Boelrijk, N. A. I. M.; Hebeda, E. H.; Verdurmen, E. A. Th.; Verschure, R. H. (ZWO-Laboratorium voor Isotopen-Geologie, Amsterdam). Geol. Mijnbouw; 50: No. 4, 619-24(Jul-Aug 1971).

Rb/Sr measurements point to an Eburnian age (around 2150 million years) for the granites and tourmaline pegmatites in the Kamativi area, southern Rhodesia. From Rb/Sr and K/Ar mineral dates it is evident that a tectonothermal event affected the area in Kibaran time, about 970 million years ago; the emplacement of the tin-bearing pegmatites was probably connected with this event. (auth)

40868 METHOD FOR MEASURING RADON AND THORON EXHALATION FROM THE GROUND. Megumi, Kazuko; Mamuro, Tetsuo (Radiation Center of Osaka Prefecture). J. Geophys. Res.; 77: No 17, 3052-6(10 Jun 1972).

A method for determining directly the rate of radon and thoron exhalation from the ground was studied. Radon and thoron gases are directly adsorbed on a layer of granular activated charcoal distributed over the ground surface, and the charcoal is subjected to γ-ray spectrometry. The radon quantity is determined from the area of the photopeak due to 0.61-MeV γ rays of ^{214}Bi and the thoron quantity from the area of the photopeak due to 2.61-MeV γ rays of ^{208}Tl. Some results of measurements obtained by this method are presented. (auth)

Site Surveys

Refer also to abstracts 40695 and 41383.

40869 (BMI-171-32(Vol.1)) ESTUARINE AND MARINE ECOLOGY. VOLUME I. FINAL REPORT AND APPENDIX A. Bioenvironmental and Radiological-Safety Feasibility Studies Atlantic-Pacific Interoceanic Canal. Lowman, F. G.; Martin, J. H.; Ting, R. Y.; (and others) (Puerto Rico Nuclear Center, Mayaguez). Jun 1970. Contract AT(26-1)-171. 143p. Dep. NTIS.

For Battelle Memorial Inst., Columbus, Ohio.

Results are presented of an extensive study which was undertaken to provide estimates of the amounts of radioisotopes which may be expected in marine food organisms as the result of nuclear excavation of an Atlantic–Pacific sea-level canal in Central America. Information is included on: radioisotope production and distribution in water, ejecta media, and marine food organisms;

fallout studies of the radioactivity of tritium in clouds from cratering shots; effects of rain on the distribution and radioactivity of fallout, and the migration of radioisotopes through the marine food cycle to man. A 41-page appendix on the production of radioisotopes by cratering explosions is included. (L.C.L.)

40870 (BMI-171-32(Vol.2)) ESTUARINE AND MARINE ECOLOGY. VOLUME II. APPENDIXES B THROUGH E. **Bioenvironmental and Radiological-Safety Feasibility Studies Atlantic-Pacific Interoceanic Canal.** Lowman, F. G.; Martin, J. H.; Ting, R. Y.; (and others) (Puerto Rico Nuclear Center, Mayaguez). Jun 1970. Contract AT(26-1)-171. 240p. Dep. NTIS.
For Battelle Memorial Inst., Columbus, Ohio.

Four appendixes to the report on bioenvironmental and radiological safety studies related to the proposed nuclear excavation of an Atlantic-Pacific sea-level canal in Central America are presented. The first appendix contains information on the physical dilution of radioactive fallout due to surface circulation of Panamanian coastal waters; radioactive decay; and biological delay. The second details procedures used to sample plankton, seawater, sediments, and fish from Panamanian coastal areas and discusses the physical environment of waters adjacent to the coasts of Panama and Colombia. The third and fourth present the methods and results of chemical analyses performed to determine the stable element concentrations in Panamanian coastal seawater and plankton. (L.C.L.)

40871 (BMI-171-32(Vol.3)) ESTUARINE AND MARINE ECOLOGY. VOLUME III. APPENDIX F. **Bioenvironmental and Radiological-Safety Feasibility Studies Atlantic-Pacific Interoceanic Canal.** Lowman, F. G.; Martin, J. H.; Ting, R. Y.; (and others) (Puerto Rico Nuclear Center, Mayaguez). Jun 1970. Contract AT(26-1)-171. 233p. Dep. NTIS.
For Battelle Memorial Inst., Columbus, Ohio.

This appendix to the report on bioenvironmental and radiological safety studies related to the proposed nuclear excavation of an Atlantic-Pacific sea-level canal in Central America presents the methods and results of chemical analyses performed to determine the stable element and radioisotope content in fish sampled from waters adjacent to Colombia and Panama. (L.C.L.)

40872 (BMI-171-32(Vol.4)) ESTUARINE AND MARINE ECOLOGY. VOLUME IV. APPENDIXES G THROUGH N. **Bioenvironmental and Radiological-Safety Feasibility Studies Atlantic-Pacific Interoceanic Canal.** Lowman, F. G.; Martin, J. H.; Ting, R. Y.; (and others) (Puerto Rico Nuclear Center, Mayaguez). Jun 1970. Contract AT(26-1)-171. 283p. Dep. NTIS.
For Battelle Memorial Inst., Columbus, Ohio.

Ten appendixes to the report on bioenvironmental and radiological safety studies related to the proposed nuclear excavation of an Atlantic-Pacific sea-level canal in Central America are presented and include information on: foraminiferal studies; the effect of a sea-level canal on fossil formations off the coast of Panama; tidal currents in the Gulf of San Miguel; clay mineralogy of Southern Gulf of Panama; fine sediment dispersal in the Gulf of San Miguel; characterization of sediments from the Tuira and Sabana River estuaries; methods for C, H, N, P, and calorimetric analysis; estimates of anchovy, plankton, shrimp, and tuna crop in Gulf of Panama; birds of Gulf of Panama; and a mathematical model for predicting the contamination of seawater resulting from radioactive fallout reaching the water surface. (L.C.L.)

40873 (NVO-1229-173) DIGITAL COMPUTER SIMULATION OF WATER TABLE. Carnahan, C. L.; Fenske, P. R. (Nevada Operations Office (AEC), Las Vegas). Aug 1971. Contract AT(29-2)-1229. 74p. Dep. NTIS.

Initial stages of development of a digital-computer method for simulation of water tables have been completed. The method may be used in regions where hydrologic data is sparse. A topographic surface, represented by a matrix of elevation values, is smoothed, raised or lowered in altitude, and compressed or expanded in amplitude, to provide a first approximation to the water table. The first approximation is then fitted to observed water elevations at preselected control points. This adjustment produces exact fitting at control points; nodes which do not correspond to control points are adjusted by amounts dependent on distance from all control points. The method is applied to the Hot Creek Valley and Pahute Mesa areas in Nevada. Possible deficiencies of the method requiring further development include lack of adequate means for verifying or correcting a computed water table by use of hydrologic data at off-matrix points, and lack of means for matching computed elevations along boundaries between adjacent matrices. Computer program functions are described and code listings are given. (auth)

40874 (WASH-1519) RIO BLANCO GAS STIMULATION PROJECT, RIO BLANCO COUNTY, COLORADO. **Environmental Statement.** (Atomic Energy Commission, Washington, D. C.). Apr 1972. 259p. (PNE-RB-25). Dep. NTIS.

The environmental impact of the proposed Rio Blanco experiment in Colorado was studied. Rio Blanco is a joint USAEC and industry effort to development the technology of using underground nuclear explosions to stimulate natural gas production. Three nuclear explosives designed specifically for this application are to be detonated simultaneously at depths from 5500 to 6990 ft. with an aggregate yield of 90 kt. The probable, adverse, and unavoidable effects of the experiment are enumerated. The irretrievable commitments of resources are discussed, and the environmental impact of contemplated future actions is described. There is no known economic alternative to nuclear gas stimulation for recovering huge quantities of gas from tight gas formations. After careful review of the environmental considerations, the AEC concluded that: the experiment will cause minor adverse effects on the local environment, including ground-motion damage to local man-made structures; brief disruption in the daily routine of local residents at the time of the detonation, and possible exposure of local residents to very low levels of radioactivity during production testing; the likelihood of an accidental release of significant amounts of radioactivity to overlying aquifers or to the atmosphere is considered to be so highly improbable as to constitute no real risk to the environment; the Rio Blanco experiment will not adversely affect the future recoverability of the valuable minerals contained in the local oil shales overlying the detonation area; the development of this technology would help meet future energy resources requirements; the benefits outweigh probable environmental costs; and the project should be implemented. (L.C.L.)

40875 LATERAL STRUCTURE-FOUNDATION INTERACTION OF STRUCTURES WITH BASE MASSES. Scavuzzo, R. J.; Raftopoulos, D. D.; Bailey, J. L. (Hartford Graduate Center, East Windsor Hill, Conn. Univ. of Toledo). Bull. Seismol. Soc. Amer.: 62: No. 2, 453-70(Apr 1972).

The interaction of lateral inertia forces of an N-mass structure with a base mass and lateral seismic motion of the foundation is formulated as an integral equation of the Volterra type. Flexibility of the foundation is based on the transient solution of a two-dimensional elastic half-space. Interaction effects are evaluated by comparing the response spectra of the free-field motion to that of the foundation motion. Results show that changes in the response spectra are significant for heavy, stiff structures such as a reactor-containment vessel. (auth)

Thermal Effluents

Refer also to abstract 42546.

40876 (BNWL-1646) POTENTIAL THERMAL EFFECTS OF AN EXPANDING POWER INDUSTRY: COLUMBIA RIVER BASIN. Jaske, R. T. (Battelle Pacific Northwest Labs., Richland, Wash.). Apr 1972. Contract AT(45-1)-1830. 114p. Dep. NTIS.

The once-through cooling capacity of the Columbia River Basin in the reach between the International Border and Bonneville Dam (River Mile 146.4) was predicted for a number of weather conditions, flow management options, and upstream developments resulting from the Columbia Treaty Dams. The study used the MAXPWR version of the COLHEAT simulation system to locate plants and compute thermal assimilative and dissipative capacity entirely within the envelope of water quality criteria promulgated by the states of Washington and Oregon. The study reveals that under these published criteria some 20 W(e) of thermal plants of 31% thermal efficiency could be sited between the International Border and the city of Pasco, Washington. An additional 10 W(e) could be accommodated on the Middle Columbia above Bonneville Dam, but the operational continuity would be subject to interruption without full integration of water management in that reach. The study also indicates that daily weather is a secondary variable in planning for plant siting. The principal factors which determine the feasibility of future use of the Columbia for once-through cooling would be the effects of the Columbia Treaty Dams on the seasonal cycle of water temperatures and the actual water management plan as it affects these temperatures down stream. Low flows raise Columbia River temperatures and tend to move thermal peaking dates forward in time by substantial amounts: as much as 60 days under post 1980 conditions. The Snake River was determined to have little or no potential capability for once-through cooling because of the extended travel time of water passing through the Lower Snake impoundments; these are projected to raise summer water temperatures above 23°C. (auth)

40877 (HEDL-TME-72-58) ENVIRONMENTAL ENGINEERING PROGRAMS. **Quarterly Technical Progress Report, January-March 1972.** Bailey, G. F. (comp.) (Hanford Engineering Development Lab., Richland, Wash.). Contract AT(45-1)-2170. 35p. Dep. NTIS.

The effects on river water temperature of waste heat discharged from power plants into rivers were studied. The modified TOPLYR-II computer code was used to predict water temperatures in the North Platte River near Glenrock, Wyo. The cooling capacities of South Atlantic and Gulf Coast rivers were calculated for given river flow conditions. The status of cooling pond technology is reviewed. (L.C.L.)

40878 EFFECTS OF THERMAL EFFLUENTS UPON THE GROWTH AND DISTRIBUTION OF FISH IN THE WHITE RIVER NEAR PETERSBURG, INDIANA. Benda, Robert Steven. Terre Haute, Ind.; Indiana State Univ. (1971). 106p. University Microfilms Order No. 72-6490.

Thesis.

A study was undertaken to determine the effects of a thermal effluent from the Indianapolis Power and Light Company Plant at Petersburg, Indiana on the growth and distribution of fish in the White River. The movement of marked fish in relation to the thermal effluent was also studied along with the structure of the fish communities; the incidence of disease, injury, and deformation among the fish; and the population size of larger fishes above and below the effluent. The study was undertaken during the warm months of 1969 and 1970. Fish were captured using an electric shocker. The specimens were weighed, measured for length, checked for parasites and injury, marked with a dye injected in a fin, and scale samples were removed for age and growth studies. The area was shocked during both summers and records were kept of recaptured fish. All statistical analyses were done with the use of computer programs. It was found that the thermal effluent from the IPALCO plant has a local effect on the White River near Petersburg, Indiana. No direct mortality was observed, and contrary to some statements in the popular press, there are fish present in the area below and immediately downstream from the thermal effluent. Fish were found to migrate out of the heated water when temperatures reached 34 to 35°C, but with the onset of cooler weather, returned to the heated area in the discharge canal. There was a reduction in the numbers of centrarchids worked with during the study (Longear sunfish, Spotted bass, White crappie, Black crappie, Green sunfish, Bluegill) in the heated water, but an increase was noted in Carp, Gizzard shad, catfishes, and carpsuckers. Analysis of scale samples for the centrarchids failed to show any evidence of direct effects from the heated water in the age-length analyses. Analysis of the weight-length and condition factor data showed that generally the centrarchids were heavier for attained length in the heated water as compared with the unheated water. Results of the mark-recapture measurements showed most of the centrarchids recaptured stayed in the area they had been originally marked. Other fish recaptured showed some movement occurred among the areas indicating the thermal effluent does not act as a barrier to the movement of fish. Although no statistical information was collected on spawning success, many young-of-the-year centrarchids were collected indicating that spawning did occur in the area. Analysis of the parasite and injury data revealed a heavy infestation of the copepod parasite, Lernaea. cyprinacea in all sections, both above and below the thermal effluent, in the river. There was little injury and damage to the fish related to the heated discharge. The overall effect of the thermal effluent from the Indianapolis Power and Light Company at Petersburg, Indiana is a local one and is observed only during the warm summer months. The fish move out of the heated water and when cool weather returns to the area the fish move back into the vacated section of the river. (Diss. Abstr. Int., B)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 40691, 40692, 42209, 42497, 42498, and 42628–42630.

40879 (CEA-R–4312) CONTINUOUS MEASUREMENT OF THERMAL NEUTRON FLUXES USING A β EMITTER PROBE. Baudry, Roland (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1972. 63p. (In French). Dep. NTIS (U. S. Sales Only).

A technique for continuously measuring thermal neutron fluxes using a β emitter probe has been developed by the Nuclear Piles Service of Saclay. The evolution of the neutron flux is followed during irradiation experiments in research reactors. Vanadium, silver, and rhodium emitters were studied; the experiment, however, principally concerned Ag emitter probes (study of the sensitivity to thermal and epithermal neutrons, response time of parasitic currents, and sensitivity drop due to loss of Ag). (auth)

40880 (INR-P–1389) EXTRAPOLATION CHAMBER FOR MEASUREMENT OF β-RAY SOURCES. Jablonska, J.; Kuchta, M. (Nuclear Research, Warsaw (Poland)). 1972. 13p. (CONF-720411-4). Dep. NTIS (U. S. Sales Only).

From Symposium on dosimetry techniques applied to agriculture, industry, biology, and medicine; Vienna, Austria (17 Apr 1972).

An extrapolation chamber is described which is used for measurements of surface dose-rates of beta-sources. The results of measurements for ^{204}Tl sources are given, and the method of calculation is presented together with the obtained accuracy. The maximum total error is 5%. (auth)

40881 (JINR–P13-6378) UNIPOLAR AND BIPOLAR MULTIPLEX SYSTEMS OF PARTICLE DETECTION. Soroko, L. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Apr 1972. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

A comparative analysis is made of unipolar and bipolar systems with particular application to Hadamard-transform scintillation detectors which are described in the JINR communications P13-5696, P13-5699, P13-5722, P13-5896, P13-6019, P13-6032, and P13-6078. The measurement error is shown to be dependent both on the structure of coding matrix at the stage of measurement and on the type of the matrix used in reconstruction of the data to be searched. The values of the mean-square errors for multiplex systems of various types are given. (auth)

40882 (JINR–P13-6391) TIME AND AMPLITUDE CHARACTERISTICS OF SCINTILLATION COUNTERS AT LARGE PULSE LOADING. Kazarinov, M. Yu.; Lyaiste R.; Merekov, Yu. P.; Petrukhin, V. I.; Ronzhin, A. I.; Khovanskii, N. N.; Tsisek, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Apr 1972. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

Time and amplitude characteristics of the scintillation counters with photomultipliers 56AVP and 56DVP are studied at pulse loading up to 2.10^7 sec^{-1} in the IHEP synchrotron (Serpukhov). (auth)

40883 (JINR–P13-6425) DEVELOPMENT OF TECHNIQUE OF PRECISE DETERMINATION OF PARTICLE COORDINATES IN PROPORTIONAL CHAMBER. Biryukov, V. A.; Zinov, V. G.; Konin, A. D.; Ponomarev, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). May 1972. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

The results are presented of experimental checking of the technique of measuring of the track coordinates in a proportional chamber with the potentiometric readout using currents induced on the filaments of the cathode. The technique allows one to reach (for the tracks perpendicular to the electrode surface) the measurement accuracy much better than the distance between the electrode filaments. The results of calculation of induced current distribution and the coordinate measurement errors are presented. (auth)

40884 (KFKI–72–30) WHOLE BODY COUNTER EFFICIENCY CALCULATIONS FOR DISTRIBUTED SOURCES IN A HUMAN PHANTOM. Andrasi, A.; Koetel, Gy. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Apr 1972. 7p. (CONF-720503–3). Dep. NTIS (U. S. Sales Only).

From second European congress on radiation protection; Budapest, Hungary (3 May 1972).

The space and energy dependence of the full energy peak efficiency of the 6″ × 4″ NaI(Tl) detector of a whole body counter was calculated by computer from input data measured on point sources. By volume integration of this empirical function, the efficiency of the counter was evaluated for a BOMAB-type human phantom. Calculations were carried out for uniformly distributed sources with gamma energies of 0.1 to 2.0 MeV, in chair, arc and scanning geometries. The calculations were extended to cases of activity confined in geometrically well-defined organs within the phantom. Measurements performed to verify the calculated values showed a better than ±4% agreement. (auth)

40885 (UJV–2775-R) ACTIVATION DETECTOR SYSTEM FOR MEASURING THE RELATIVE DISTRIBUTION OF A NEUTRON FLUX. Otopal, P.; Kralova, V. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Jan 1972. 13p. (In Czech). Dep. NTIS (U. S. Sales Only).

The construction, calibration, and use of an activation detector as an instrument for measuring neutron flux, as developed for reactor shielding experiments, is described. The determination of the calibration coefficients is developed mathematically. Metal foils or powders were used in the detectors, the selection of which was based on such factors as the energies in the beam under study and the purity, availability, and properties of detector materials. Data on the components and properties of a number of detectors are tabulated. (TTT)

40886 LARGE AREA SCINTILLATION COUNTERS. I. PROPORTIONAL SCINTILLATION COUNTERS. Govorkov, B. B.; Chukin, V. S. (Lebedev Inst. of Physics, Moscow). Probl. Fiz. Elem. Chastits At. Yadra; 2: No. 3, 763-800(1972). (In Russian).

A review of properties of large area scintillation counters is given. The questions of light collection in scintillators, different types of light guides and materials for the optical contact are considered. The use of twisted strip light guides allows one to receive the uniformity ±5% and the energy resolution ±13%. (58 references). (auth)

40887 RADIATION COUNTING TUBE OF THE GEIGER–MULLER TYPE. Maillot, Jean-Paul (to International Standard Electric Corp.). U. S. Patent 3,665,189. 23 May 1972. Filed 22 Jan 1970.

A Geiger–Mueller counting tube which includes a plurality of longitudinally disposed cathode sections of different sensitivities coaxially surrounding a common anode to permit simplified measurement of a wide range of radiation on a single meter scale without switching is described. (auth)

40888 NEUTRON THRESHOLD DETECTOR ^{103}Rh. Lomonosov, I. I.; Firsov, E. I.; Cherenda, N. G. This paper was summarized in At. Energ. (USSR); 30: No. 6, 537(Jun 1971) as paper No. 503/5890. (In Russian).

Full copy of this paper is held by TIC.

The performance of rhodium-103 for in-core neutron flux monitoring is reported. Neutrons react with rhodium-103 via the reaction ^{103}Rh(n,n′)^{103m}Rh. An aqueous solution of the complex compound triethylenediamine rhodium nitrate was used. The activity was measured by recording the conversion electrons with a single-channel liquid scintillation counter. The error in the flux measurement was estimated at 10%. (W.H.K.)

40889 USE OF A COMPRESSED COMPOSITE OF Si AND Sb TO MEASURE NEUTRON ENERGIES IN THE RANGE 13 TO 15 MeV. Cox, A. J.; Jarjis, R. A. (Univ. of Astron, Birmingham, Eng.). Int. J. Appl. Radiat. Isotop.; 23: No. 6, 301-2(Jun 1972).

It has been suggested that the measurement of the variation of activation cross-section ratio with incident neutron energy could be used for the measurement of neutron energies once the variation is known. (Cox and De Kock, 1971). The advantages and limitations of the technique are given. In the present work the limitations were overcome by using two substances where the cross-section of one rose with neutron energy and that of the other decreased so that the ratio of cross-sections was a steep function of neutron energy. Also materials were chosen with similar half-lives with large cross-sections and well-resolved γ-ray peaks. These materials were mixed together and pressed into a composite. This was irradiated by neutrons and the ratio of the γ-ray intensities measured as a function of neutron energy. The two materials chosen to form the composite were ^{121}Sb and ^{28}Si. (UK)

40890 STUDIES ON AFTER EFFECTS IN GM COUNTERS WITH PULSED LOW ENERGY X-RAYS. Narita, Yuichi (Akita

Univ., Japan). Oyo Butsuri; 41: No. 2, 143-50(Feb 1972). (In Japanese).

After effects in GM counters of organic and halogen quenched types were studied by the use of low energy x-ray bursts from a pulsed x-ray generator. From the experimental results, it is shown that the probability of an after pulse occurring in the irradiation of low energy x-ray bursts is much smaller than that obtained with ~1 MeV x-ray bursts. It was found that after pulses are not associated directly with the main pulse, and the probability of their appearance depends on the intensity of the x-ray burst and the position of the irradiation. Especially when the vicinity of the cathode was irradiated, a considerable increase in the number of after pulses was observed. As for the time distribution of after pulses, the experimental results were similar to those obtained with ~1 MeV x-ray bursts. (auth) (Japan)

40891 DESIGN AND EVALUATION OF A SCANNING-BED WHOLE-BODY COUNTER FOR USE IN CLINICAL STUDIES. Watts, J. R.; Erickson, J. J.; Kramer, C. E.; (and others) (Vanderbilt Univ., Nashville). Health Phys.; 23: No. 1, 63-6 (Jul 1972).

The Vanderbilt University whole-body counter was redesigned in order to improve its versatility and to provide for a spatially independent detection efficiency. A scanning-bed geometry was used. The new system is capable of determining absolute amounts of radioactivity in selected regions of the body. It is being used to determine organ distribution of radiotracers as well as whole-body counting of lower levels of radioactivity. (auth) (UK)

40892 STEREO MAGNETIC TAPE SYSTEM FOR RADIOACTIVE TRACER FIELD EXPERIMENTS. Bain, C. A. R.; McMurray, W. R.; Rajdl, J. F. (Southern Universities Nuclear Inst. Faure, S. Afr.). Int. J. Appl. Radiat. Isotop.; 23: No. 6, 271-7(Jun 1972).

A portable detection apparatus is described which makes it possible to undertake radioisotope experiments where transient changes in count rate must be observed even in difficult environmental conditions. In addition to conventional scaler, ratemeter, and chart recorder facilities the apparatus includes a commercially available stereo tape recorder. The output pulses from either one or two scintillation detectors are recorded on one stereo track and time pulses from a crystal oscillator are recorded on the other. The data are read out at the laboratory into a multi-channel analyzer operated in multiscaler mode using the time pulses to actuate the address advance. This system accurately reproduces the count rate as a function of time in the original data. The operating performance of the system is discussed and illustrated by means of results obtained from radioisotope tracer studies of sand movement on the sea floor near harbor installations. (auth) (UK)

40893 SPECTRAL COMPARISON BETWEEN SOME SOLID SCINTILLATORS USED IN THIN-LAYER RADIOCHROMATOGRAPHY FOR β-RADIOLUMINESCENCE DETECTION OF TRITIUM. Prydz, S.; Seim, T.; Koren, J. F. (Univ. of Oslo). Phys. Norv.; 4: No. 3-4, 247-50(1970).

The emission spectra of β-excited luminescence have been obtained for three scintillators—namely anthracene, sensitized zinc silicate, and frozen benzene—which have all earlier been suggested as suitable for label activity determination in radiochromatography. The spectra are fully corrected for the wavelength-dependent sensitivity of the measuring system. The relative usefulness of three scintillators in combination with a particularly sensitive photodetector is given as scintillation detectabilities. Finally photon yields and energetic efficiencies are stated. From these quotations the usefulness of the scintillators in combination with other known detectors can be also judged. (auth)

40894 CALIBRATION OF THE 1383 A IONISATION CHAMBER FOR ^{67}Ga. Lewis, V. E.; Woods, M. J.; Goodier, I. W. (National Physical Lab., Teddington, Eng.). Int. J. Appl. Radiat. Isotop.; 23: No. 6, 279-83(Jun 1972).

The standardization of ^{67}Ga was carried out giving a calibration figure of 9.93 pA/mCi for the type 1383A ionization chamber used without liner. The random uncertainty is ±0.4% for a 99% confidence level, and the systematic uncertainty is estimated at ±1.0%. The half-life was measured as 78.26 ± 0.07 h and that of the 93 keV level in ^{67}Zn as 9.15 ± 0.15 μs. Both uncertainties are for 99% confidence levels. (auth)

40895 DIRECTIONAL PROPERTIES OF A SIMPLE SCINTILLATION DETECTOR. Petr, Ivo. Jad. Energ.; 18: No. 6, 194-8(Jun 1972). (In Czech).

A general analytical solution for the detection cross section and efficiency of cylindrical scintillators are presented for a monodirectional and isotropic field of gamma-rays. Two situations, a monoenergetic and non-monoenergetic radiation, were considered and the theory was extended for the scintillator of a more complicated shape. The theoretical results are confirmed by the experiment. (auth)

40896 RADIATION SURVEY METER COUNTING LOSS COMPENSATION CIRCUIT. Nirschl, J. C.; Mooney, G. E. Jr. (to Secretary of the Army). Canadian Patent 894,494. 29 Feb 1972.

A method is disclosed for compensating for counting or dead-time loss which causes a reduction in current at high dose levels in radiation survey meters. A zener diode is connected in circuit with a resistive network in the output circuit of the operational amplifier. For higher radiation dose levels, the output voltage of the operational amplifier exceeds the voltage at which the zener diode starts conducting, and the resulting impedance change in the output circuit causes additional current flow in the current meter. The dead-time effect of the radiation detector can be adequately compensated for by proper selection of a zener diode and associated resistance network. (E.M.T.) (Canada)

40897 MEASUREMENT OF INTERACTION CROSS SECTIONS OF FAST NEUTRONS AND GAMMA RAYS. Ghose, A. M. (Bose Inst., Calcutta). pp 15-33 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

Apparatus and techniques for fast neutron and photon cross section measurements are reviewed. The experimental geometries used and the characteristics of the detector systems employed are discussed in some detail. (J.W.R.)

40898 MEASUREMENT OF THE GAMMA SENSITIVITY OF THE 4π BETA COUNTER IN 4π BETA–GAMMA COINCIDENCE SYSTEMS. Srivastava, P. K.; Khara, G. D.; Gupta, U. C. (Bhabha Atomic Research Centre, Trombay, India). pp 213-6 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

The gamma ray sensitivity of the 4π beta counter gives rise to an important correction factor in the 4π beta–gamma coincidence counting of radionuclides with complex decay schemes. The method of determining the gamma counting efficiency of the 4π beta counter for the radionuclide ^{60}Co is described. A value of (0.213 ± 0.016)% was obtained for the gamma efficiency. (auth)

40899 CALIBRATION OF FAST NEUTRON DETECTORS FOR 14-MeV NEUTRONS FROM A (d,t) GENERATOR. Misra, S. C.; Gupta, U. C.; Rao, U. S. (Bhabha Atomic Research Centre, Trombay, India). pp 245-53 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

The neutron yield of the (d,t) generator is measured by activation of copper foils using the reaction ^{63}Cu(n,2n)^{62}Cu. Copper foils irradiated at known distances from the target are standardized in a 4π beta proportional counter. Correction for the absorption of positrons in the foils is measured by using foils of various thicknesses. The energy spectrum of the neutrons hitting the foil has been calculated for the system. The cross section calculated from the excitation curve and the neutron spectrum has been used for determining the flux. The response of two fast neutron detectors, a recoil proton counter and a Bonner sphere type dosimeter has been measured. (auth)

40900 OPTIMUM PLACEMENT OF DETECTORS IN A STATIC MULTIDETECTOR–STRETCHER WHOLE-BODY COUNTING ASSEMBLY. Hukkoo, R. K.; Unnikrishnan, K. (Bhabba Atomic Research Centre, Trombay, India). pp 389-403 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

The relatively high sensitivity and uniformity of response of a multidetector-stretcher geometry are factors recommending its use in low level in-vivo counting. To obtain optimum sensitivity and minimum deviation consistent with the size and number of detectors available, consideration must be given to the most efficient placement of detectors. A semiempirical method is proposed to arrive at the best placement of detectors for such a geometry for whole-body counters. The summed response of the geometry is predicted over a stretcher length of 170 cms using four 4" dia × 3" thick NaI(Tl) crystals for ^{137}Cs. Various criteria applicable to minimize the variation are discussed. (auth)

40901 IN VIVO MEASUREMENT OF RADIOACTIVITY USING SHADOW-SHIELD WHOLE-BODY MONITOR (CALIBRATION STUDIES). Khan, A. A. (Tarapur Atomic Power Station, India). pp 405-16 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

Studies carried out to calibrate the monitoring conditions and the standardization of the positions for a shadow shield whole body monitor supplied by Body Burden Measurements Section, BARC are described. Results of potassium estimation are also given. (auth)

40902 VERSATILE LOW-BACKGROUND GAS-FLOW COUNTER FOR MEASUREMENT OF LOW SPECIFIC ACTIVITY OF ALPHA AND BETA RADIATIONS. Abani, M. C.; Peshori, L. H.; Soman, S. D. (Bhabha Atomic Research Centre, Trombay, India). pp 569-73 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

Fabrication details and operational characteristics of a disc-shaped, flow-type counter for estimation of low level alpha and beta activities are described. For assay of alpha active samples, the counter is operated in the proportional region (plateau length 150 V, slope 5% per 100 V). The counter is operated in the GM region (plateau length 100 V, slope 5% per 100 V) for beta estimation. The background obtained is less than 1 cpm in a 15 cm lead shield with an anticoincidence umbrella of a plastic scintillator slab and the counting efficiency is 40% for ^{40}K betas. In the proportional region, the background is 4 counts per hour with 31% efficiency for uranium alphas. Use of this counter in assessing environmental, radioecological and bioassay samples is cited. (auth)

40903 LARGE-WINDOW GAS-FLOW-TYPE TWIN COUNTER WITH MULTIWIRE ANODE FOR LOW-LEVEL BETA RADIOACTIVITY MEASUREMENTS. Sethi, S. K.; Arora, P. K. (Bhabha Atomic Research Centre, Trombay, India). pp 575-84 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

For low level counting one requires a counter with a high detection efficiency, low background, large counting area and thin window. Very often, one has to strike a balance between the various divergent parameters. The construction of a large window gas-flow type Geiger counter is described which takes care of all the parameters favorably. Argon bubbled through ice-cooled isopropyle alcohol was used as a counting gas mixture. The performance of the counter was evaluated in terms of plateau, detection efficiency, background and stability. The figure of merit of the counter under report is compared to that of a commonly used low background counter, GEC type GY 4LB. The advantages of using a twin-counter over a single counter are discussed. (auth)

40904 AIR MONITOR FOR CONTINUOUS MEASUREMENT OF AIRBORNE ^{239}Pu. Singh, A. N.; Chugh, P. K. (Bhabha Atomic Research Centre, Trombay, India). pp 585-93 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

A fixed filter air monitor for the continuous measurement of airborne ^{239}Pu by the alpha spectrometry technique using a silicon surface barrier detector is described. It is shown that a thin protective film could be used to protect the delicate and expensive detector against contamination. The design of the sampling probe keeps the degradation of alpha energy caused by the film to a minimum. The system is capable of indicating alarm at a level of 8 MPC hours in presence of natural activity. A number of experiments using different surface barrier detectors have been performed and the detector best suited for the present work is indicated. (auth)

40905 BETA RESPONSE OF ULTRATHIN CRYSTALS OF ANTHRACENE. Vaze, P. K.; Peshori, L. H. (Bhabha Atomic Research Centre, Trombay, India). pp 601-6 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

The fabrication details of ultra-thin crystals of anthracene and the study of their optimum thicknesses for measurement of soft beta emitters are described. Anthracene is deposited uniformly on glass substrates in a vacuum evaporation system to get different thicknesses. The relative response of the thin crystals (0.5 mg/cm^2 to 33.4 mg/cm^2) is obtained for beta radiations from ^{14}C and hard beta emitters like ^{60}Co, ^{204}Tl, Radium D–E and ^{90}Sr–^{90}Y. (auth)

40906 IMPROVED INSTRUMENTAL DEVICES FOR RADIOMETRIC MEASUREMENTS IN MINES AND LABORATORIES. Sivaraman, K.; Chimote, J. S.; Lall, Yudhishtar (AMD Physics Lab., Trombay, India). pp 607-13 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

An automatic G–M or scintillation arch for grading the activity of loads of ores as it is brought out of the mine so that it can be dumped in the appropriate stockpile is described. Also, a rapid core scanner using a scintillation detector for grading the activity of core samples moving on a conveyer belt is described. (W.H.K.)

40907 ON-LINE REACTIVITY METER FOR FAST REACTORS BY MEANS OF ^{252}Cf NEUTRONS. Seifritz, W. (Technische Univ., Hanover). pp 70-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A two-detector reactivity meter is described. It is based on a randomly pulsed source. The source neutrons are injected into the reactor from a fission chamber covered with ^{252}Cf, operating in current mode. During the emission of prompt neutrons, fission fragments are released which are detected by ionization in a neutron-nonsensitive filling gas (e.g., Ar). The response signal of the reactor is recorded in a second chamber (^{3}He, current mode). By cross-correlation of the fluctuating output signals of both chambers the reactivity can be determined if the arrangement has been calibrated in the delayed critical state at zero power. (auth)

40908 APPLICATION OF SOLID STATE TRACK DETECTORS FOR AUTORADIOGRAPHY, USING INDUCED RADIOACTIVITY. Baumbach, H. (Zentralinstitut fuer Isotopen- und Strahlenforschung, Leipzig). ATOMKI (At. Kut. Intez.) Kozlem.; 13: No. 3, 93-9(Nov 1971). (In German).

A number of elements (e.g. B, N, O, Al) have no radionuclides applicable for autoradiographic investigations. To study distributions of these one can use, among other things, recordings by solid state track detectors (SSTD) of the alpha radiation obtained from nuclear reactions induced in these nuclei. Taking into account available literature of the last two years, a brief summary is given of the conditions of recording of charged particles by SSTD. On the basis of experimental work performed in Leipzig (Zentralinstitut für Isotopen and Strahlentechnik), the factors influencing the autoradiographic images obtainable by silver halide emulsions and SSTD's are dealt with. For the case of B distribution in Si the lower limit of detectability is estimated. Mention is made of experiments carried out in ATOMKI on influencing SSTD sensitivity during the process of exposure as well as before and during track etching. The possibility of automatic evaluation of induced autoradiograms by such electronic aids as DENSITRON (Zfi, Leipzig) and QUANTIMET (Metals Research Ltd, Cambridge) is also considered. (1 figure) (auth)

40909 DESIGN AND CONSTRUCTION OF A TIME CONTROL FOR NUCLEAR EQUIPMENT. Oropeza, Lorenzo Maldonado. Mexico City; Instituto Politecnico Nacional (1972). 87p. (In Spanish).

Thesis.

The concepts of the statistics applied to the counting of radioactive particles emitted by a source are presented. Counting statistics is the manner of knowing with great precision the function of the system in which time control intervenes. The description and functioning of a time control system for nuclear equipment is shown by block diagrams. The basic units which integrate the control system are then designed. The results obtained are reported. (J.S.R.)

40910 DEVICE FOR STUDYING RADIATION SOURCES. Brethon, J. P.; Charles, Pierre; Martin, Andre (to Commissariat a l'Energie Atomique). French Patent 2,069,904. 10 Sep 1971. Filed 3 Dec 1969. (In French).

A device for studying radiation sources is described. It is particularly well suited to high precision coincidence spectrometry measurements. It consists of: a chamber with two movable detectors connected to a liquefied gas cooling reservoir by a double walled tube; a source holder positioned axially inside the chamber; two detector holders sliding on guides which are symmetric in relation to the source holder and connected by a flexible pipe to the tube in such a way as to allow the circulation of the liquefied gas towards the inside of the source holders and the evacuation of this gas up to the reservoir; and separate controls for determining the position of the detectors on the guides. (France)

40911 METHOD AND EQUIPMENT FOR IMPROVING dc GAS FLOW IONIZATION CHAMBERS. Blondel, Maurice; Dalmazzone, Jean (to Commissariat a l'Energie Atomique). French Patent 2,079,808. 18 Oct 1971. Filed 13 Feb 1970. (In French).

A procedure enabling high precision results to be obtained from dc gas flow ionization chambers is described. The principal application of the procedure is the monitoring of atmospheric radioactivity. A constant gas pressure, slightly in excess of the maximum pressure likely to be assumed by the atmosphere, is maintained in an ionization chamber. The current generated by the ionization chamber at constant pressure is corrected in such a way that the activity of a given volume of gas at atmospheric pressure is obtained. (auth)

40912 RADON DETECTION. Alter, Henry Ward; Price, Paul B. (to General Electric Co.). U. S. Patent 3,665,194. 23 May 1972. Filed 27 Dec 1968.

Method and apparatus for detecting and monitoring radon gas and its alpha-emitting daughter products are described. A sheet of track-registration material is exposed in an area to be monitored, the material having the property of forming damage tracks along paths traversed by alpha particles. After exposure, the material is etched with a reagent to enlarge the tracks, this process making them visible so they can be counted. The number of tracks formed during the exposure period is a measure of the amount of radon and radon daughters present in the monitored area. The invention is useful as a dosimeter to monitor mine atmospheres, and also has applications in uranium prospecting. (9 figures) (auth)

Radiation Dosimeters

Refer also to abstract 41063.

40913 (CEA-N-1521) CALIBRATION CHARACTERISTICS AND RESPONSE OF THE PORTABLE IONIZATION CHAMBER BABYLINE 20. Troesch, Gilbert; Simoen, Jean-Pierre; Labourie, Jean-Louis (Commissariat a l'Energie Atomiue, Saclay (France). Centre d'Etudes Nucleaires). Feb 1972. 18p. (In French). Dep. NTIS (U. S. Sales Only).

The portable ionization chamber Babyline 20 is a detector currently employed in radioprotection for measurements of external irradiation. It is particularly suitable for measurements of absorbed doses and absorbed dose rates for photons and electrons in human tissues at depths of 7 and 300 mg $\cdot$ cm^{-2}. The correct interpretation of the measurements requires a knowledge of certain operational characteristics. The physical and electronic characteristics of Babyline 20 are described. (auth)

40914 RADIOTHERMOLUMINESCENCE OF (ZnS:CdS:Ag:Ni:Co) PHOSPHORS IRRADIATED WITH BETA RAYS. Elmanharawy, M. S. (Cairo Univ.); Mostafa, Z. E. A. Czech. J. Phys.; 22: No. 4, 318-25(1972).

Radiothermoluminescence characteristics were studied for a number of (ZnS : CdS : Ag : Ni : Co) phosphors, with various cobalt impurity contents, after exposure to ^{90}Sr beta rays at room temperature. Thermoluminescent spectra show a peak wavelength of 7000 Å, which remains unchanged with increase in cobalt concentration. Thermoluminescence curves exhibit a single well-defined peak appearing at temperatures far above room temperature. This peak shifts to lower temperatures with increasing cobalt content. The relation between thermoluminescence response and dose is linear over the dose range of 1 to 500 rads. Thermoluminescence measurements made after storing the irradiated phosphor for 48 hours in dark have revealed an information loss of 4% over this storage period. The radiothermoluminescence characteristics, storage capacity, and storage stability of these sulfide phosphors compete reasonably with those of lithium fluoride over the dose range of 1 rad to 500 rads. (auth)

40915 RELATIVE THERMOLUMINESCENCE EFFECTS OF ALPHA- AND BETA-RADIATION. Zimmerman, D. W. (Oxford Univ.). Radiat. Eff.; 14: No. 1-2, 81-92(May 1972).

A study was made of the relative thermoluminescence (Tl) response to α and β radiation of six phosphors (two types of natural fluorite, CaF_2 : Mn, CaF_2 : Tb, $CaSO_4$: Mn, and quartz) using samples which are thin compared to the range of the α particles. The α and β radiations induce the same glow peaks, but at low doses (<100 rads) the TL response per rad of α radiation (3.7 MeV) is less than that per rad of β radiation in all the glow peaks studied. The α efficiency ranges from 53% for CaF_2 : Mn to 2% for quartz (110°C peak) at 3.7 MeV and decreases with decreasing α-particle energy. At higher doses (10^6 to 10^7 rads), the TL responses to α and β radiation become equal within 15%; most of the glow peaks are in or near saturation at these doses. The higher the β-dose at which a peak saturates, the higher is the α-efficiency (at low doses) of that peak. The results support the interpretation that the α-efficiency is low because the phosphor is near or in saturation in the localized region near the α-path. This interpretation is given quantitative support by a theoretical calculation of the localized energy-density. (auth)

40916 INDIVIDUAL DOSIMETRY IN A CATASTROPHY (METHODOLOGY). Wachsmann, F. Strahlenschutz Forsch. Prax.; 11: 29-35(1971). (In German).

The suitability of various dosimeters for individual persons during civil defense emergencies is analyzed. For γ ray determination, condensor chambers, glasses, thermoluminescent dosimeters, films, and self-developing films are considered. For neutron determination, nuclear track methods, foil etchings, and activation foils are discussed. (6 figures). (H.B.G.)

40917 SCATTERING OF 14-MeV NEUTRONS. IV. Sato, Yuji; Hiraoka, Eiichi; Azuma, Toshio. Annu. Rep. Radiat. Center Osaka Prefect.; 12: 39-40(1971).

To observe scattered 14-MeV neutrons from the T(γ,n) reaction, a gate circuit using neutron and alpha pulses was tested to decrease the backgrounds. For neutron detection, the pulse shape discrimination circuit (PSD) was used to cut the lower energy pulses than 2 MeV. For alpha detection, the energy-gated pulses using a single-channel analyzer were used to decrease backgrounds. (auth)

40918 RADIATION DOSIMETER USING GAS OF GREATER ELECTRON AFFINITY AND MOLECULAR MASS THAN AIR. Richter, Henry L. (to Henry L. Richter Corp.). U. S. Patent 3,665,197. 23 May 1972. Filed 15 Sep 1969.

A radiation dosimeter wherein a sealed container encloses an ionizable gas and dielectric members for separating a triboelectric charge is improved wherein the ionizable gas comprises a material having a greater mass and greater electron affinity than air. Specific materials include sulfur hexafluoride and fluorinated hydrocarbons. (auth)

40919 RESPONSE OF LiF TO FAST NEUTRONS. McGinley, P. H. (Georgia Inst. of Tech., Atlanta). Health Phys.; 23: No. 1, 105-6(Jul 1972).

Thermoluminescent dosimeters may be used in conjunction with tissue-equivalent ionization chambers to establish doses due to neutrons and γ-rays for radiation fields composed of a mixture of these two radiations; and in order to separate the total absorbed dose into these components, knowledge of the relative neutron response of the thermoluminescent dosimeter is required. This is defined as the ratio of the TLD response produced by a neutron field that will deposit 1 rad in tissue to the TLD response produced by an exposure of 1 R of ^{60}Co γ-radiation, and was obtained for TLD 100 and 700 at a number of neutron energies. The dosimeters were exposed to a fast neutron dose in the range 2 to 5 rads. Results are tabulated. The relative neutron response is expressed as a linear function of the neutron energy. (UK)

40920 OPERATIONAL EVALUATION OF A NEW HIGH SENSITIVITY THERMOLUMINESCENT DOSIMETER. Webb, G. A. M.; Dauch, J. E.; Bodin, G. (Teledyne Isotopes, Westwood, N. J.). Health Phys.; 23: No. 1, 89-94(Jul 1972).

A new dosimeter is described which is capable of routine exposure measurements down to less than 1 mR. This dosimeter consists of a dispersion of calcium sulphate: dysprosium thermoluminescent dosimetry phosphor in Teflon (P.T.F.E.). The principal features of this dosimeter are its high sensitivity and relatively low fading of the stored signal. A detailed evaluation of the precision at various exposure levels is presented, which shows a standard deviation of ±15 at 1 mR, ±6 at 10 mR and ±3.5% at 100 mR. The background signal from an unirradiated, freshly annealed dosimeter is 1 mR equivalent. The response was measured from 1 mR to 5000 R, and the glow curve structure and linearity are shown. The fading was measured and can be made as low as 10% in the first day and 20% in the first week by readout with a suitable pre-heat cycle. The re-use capability was studied and the dosimeter shows less than 5% overall change in sensitivity on successive re-use cycles. The response to other environmental effects such as ultra-violet light, mechanical vibration, ultrasound and sunlight is generally small, of the order of a few mR equivalent; precautions are, however, described which should be observed for good results at extremely low levels. Possible applications of this dosimeter to short-term personnel dosimetry are reviewed. (auth) (UK)

40921 CHANGES IN GAMMA SENSITIVITY OF ^{7}LiF DOSIMETERS. Block, P. H.; Weber, R. J. (Univ. of Pennsylvania, Philadelphia). Health Phys.; 23: No. 1, 123-4(Jul 1972).

Thermoluminescent dosimeters insensitive to thermal neutrons are often used to measure the γ-dose component in a mixed neutron and γ-radiation field. The use of ^{7}LiF for this purpose is studied. It was thought that there might be a change in γ-sensitivity caused by neutron irradiation, and this was tested. It was found that no change in γ-sensitivity of TLD-700 dosimeters was apparent after a neutron exposure of 1600 rads. (UK)

40922 RESPONSE OF TLD-700 THERMOLUMINESCENT DOSIMETERS TO PROTONS AND ALPHA PARTICLES. Jaehnert, B. (Hahn-Meitner Inst. fuer Kernforschung, Berlin). Health Phys.; 23: No. 1, 112-14(Jul 1972).

The thermoluminescence yield of materials depends on the LET (linear-energy transfer) of the ionizing particles, and for highly enriched LiF (TLD-700), yields were determined as a function of LET up to a LET value of 340 keV/μm. Experimental details are given. Alpha irradiation was performed with a ^{210}Po source (α-energy 1.7 to 3.7 MeV), to doses of 5×10^2 to 10^5 rads. Proton irradiation was carried out with a Van de Graaff generator using the nuclear reaction ^{2}P(^{3}He,^{1}P)^{4}He (p-energy 2.4 to 13.3 MeV), to doses of 3 to 34 rads. The glow curves obtained depended on the character of the irradiation. Two peaks were seen (230°, 290°C), and the height of the higher temperature peak relative to the whole TL intensity increased with increasing LET of the ionizing particles. The measured relative TL sensitivity for 3.7 MeV α-particles compared with ^{60}Co γ-rays as a function of the absorbed dose is shown graphically, together with the dependence of the TL sensitivity in the low dose region on the average LET of the particles. Below a LET of about 5 keV/μm the TL yield was rather independent of LET and equal to that for γ-rays, but above this value the TL sensitivity decreased monotonically with increasing LET and the slope of the curve could be approximated by an exponential function. The slope of the relative TL yield curve as a function of LET can be explained by a saturation effect during the filling of traps in the path of highly ionizing particles such as protons and α-particles. In the temperature region 200° to 300°C hole capture appears to be the major process occurring in LiF, and it is therefore only necessary to consider the trapped holes; the trap theory is discussed in this context. (UK)

40923 PERSONNEL MONITORING IN DIAGNOSTIC RADIOLOGY. Bushong, S. C. (Baylor Univ., Houston, Tex.). Brit. J. Radiol.; 45: No. 534, 472(Jun 1972).

The position of personnel monitoring devices is discussed and the literature briefly reviewed in relation to the recommendations of the Radiation Protection Committee of the British Institute of Radiology that the film badge should normally be worn on the trunk at waist level because the critical/organs for most diagnostic x ray work are the gonads and bone marrow. It is suggested that this conflicts with a second recommendation that the critical organs are considered to be the gonads, lens of the eye and red bone marrow. It is pointed out that on the basis of bone marrow dose alone, the head and neck region are as important as the trunk for monitoring and more so if a protective apron is worn. (UK)

40924 INDIVIDUAL MONITORING IN DIAGNOSTIC RADIOLOGY. Langmead, W. A. (British Inst. of Radiology, London). Brit. J. Radiol.; 45: No. 534, 473(Jun 1972).

The positioning of personnel monitoring devices is briefly discussed in relation to Bushong's criticisms of the recommendations of the Radiation Protection Committee of the British Institute of Radiology. It is pointed out that unlike investigations in the U.S.A., in the U.K. measurements of P have indicated that film badges should be worn on the trunk of the body during diagnostic radiology, despite the fact that they may be covered by an apron for a small fraction of the working week. P is defined as the dose received on the film worn outside the apron to that worn under the apron. (UK)

40925 EXPOSURE STANDARD IN THE ENERGY RANGE 0.3 TO 3.0 MeV. Rao, P. S.; Gupta, U. C.; Govindarajan, K. N. (Bhabha Atomic Research Centre, Trombay, India). pp 229-35 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

The Exposure Standard that has been established in the energy range 0.3 to 3.0 MeV using a graphite cavity ionization chamber and the Townsend balance system for the charge measurement with a vibrating-reed electrometer as the null indicator is described. The accuracy of the standard is estimated to be 1.2% and the relevant correction factors viz. the correction for wall attenuation, scattering from surroundings and supports etc., are also discussed. (auth)

40926 PANORAMIC EXPOSURE ASSEMBLY. Rao, P. S.; Gupta, U. C.; Govindarajan, K. N. (Bhabha Atomic Research Centre, India). pp 237-43 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

The Panoramic Exposure Assembly that has been designed and fabricated for the accurate intercomparisons and routine calibration of dosimeters is described. A preset timer controls the pneumatic source positioning system. A radium source (9 mg.) whose exposure rate has been standardized is used for the calibration of detectors. The exposure intervals can be present from a few seconds to 9999 seconds. A number of dosimeters can be clamped in an arc of 30 cm radius at a height of 183 cm above ground level. It has a precision better than a fraction of a percent for intercomparisons and an accuracy better than ±3% for calibration of dosimeters. (auth)

40927 THERMOLUMINESCENCE STUDIES IN COBALT CHELATES. Sen Gupta, S.; Sarup, S. (Bhabha Atomic Research Centre, Trombay, India). pp 289-98 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

Thermoluminescence studies have been carried out on the cobalt (111) complex sodium-hydrogen-ethylene diamine-tetra-acetate-nitro cobaltate monohydrate [$Na(CoHY^{-3}/NO_2)H_2O$] by irradiating with different ionizing radiations. On annealing, two glow peaks at 100° and 200°C have been observed on the material irradiated with beta, gamma and x-rays while thermal neutron irradiation yields an additional peak at 235°C. A linearity in the TL intensity and γ-dose in the range of 1×10^4 to 6×10^6 rads has been observed. (auth)

40928 EFFECTS OF RESIDUAL THERMOLUMINESCENCE IN TLD PHOSPHORS. Sunta, C. M.; Kathuria, S. P.; Bapat, V. N. (Bhabha Atomic Research Centre, Trombay, India). pp 307-21 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

The reading procedure of a thermoluminescent dosimeter (TLD) requires heating of the phosphor to about 300°C. It is shown that this procedure leaves a significant part of the glow curve unemitted. This unreleased part may be called residual thermoluminescence (RTL). Full glow curves are recorded for LiF and fluorite TLD phosphors by warming from room temperature to 550°C. The highest temperature glow peaks in LiF and fluorite TLD phosphors are at about 400°C and 500°C respectively. Normal reading procedure of TLD leaves these peaks residual in the sample. These residual peaks affect the sensitivity and linearity in the subsequent use of such phosphors. Exposure to ultraviolet rays produces most of the lower temperature glow peaks at the expense of the high temperature residual peak. This effect can be used for obtaining repeated readings. Importance of RTL peaks in determining the pre-exposure annealing temperature is shown. (auth)

40929 THERMOLUMINESCENCE OF SOME MINERAL SAMPLES AFTER GAMMA IRRADIATION. Sunta, C. M.; David, M. (Bhabha Atomic Research Centre, Trombay, India). pp 323-51 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

Thermoluminescence glow curves of a variety of natural crystals and ores were studied by heating from room temperature to about 550°C after gamma ray irradiation. The specimens tested are fourteen of quartz, four of topaz, four of corundum, two of calcite, two of rock-salt, fourteen of fluorites and eleven of different ores which were collected from different places. It is observed that glow peak temperatures are common in different samples of the same mineral irrespective of their place of origin or physical appearance. Almost all the mineral specimens showed the thermoluminescence after gamma ray irradiation. Common features of glow curves are discussed. (auth)

40930 THERMOLUMINESCENCE DOSIMETERS FOR SMALL DOSAGES. Kumar, Narendra; Sootha, G. D.; Mahendru, P. C. (National Physical Lab., New Delhi). pp 353-5 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

Single crystals of KCl doped with Ca have been studied as thermoluminescent dosimeters for the measurement of exposures in the range of 5 mR to 10 R. For a heating rate of 40°C/min., a thermoluminescence peak at 85°C is the only peak observed in KCl : Ca crystals for this range of exposures. The area under the 85°C thermoluminescence peak varies directly with the exposures received by these crystals. Effects of fading at room temperature (~20°C) and at 0°C and also those of continuous and repeated radiations for the same amount of exposure received by the KCl :

Ca crystals have also been studied. A possibility of using these crystals for the measurement of small exposures such as for clinical purposes, is suggested. (auth)

40931 FILM DOSIMETRY WITH HIGH-ENERGY RADIATION (^{60}Co) AND ITS APPLICATIONS. Balakrishnan, I. S.; Ramaswamy, S.; Lakhmanan, A. V. (Cancer Inst., Madras). pp 453-62 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

The advantages and drawbacks of using a film instead of an ion chamber for dose distribution measurements with high energy ^{60}Co gamma radiation are indicated. The method of calibrating a film and the determination of its response at increasing depths in a tissue equivalent phantom are outlined. The linearity of the relationship between the percentage depth dose in the phantom and the density obtained on the film is established for ^{60}Co gamma rays by using three different tissue equivalent phantoms. The applications of film dosimetry for the determination of isodose curves in the cases of open fields, wedged fields etc., with the precautions to be observed, are discussed. The use of the film to study the "build-up" of dose in the superficial layers of tissue equivalent material is also shown. The usefulness of the film in determining resultant dose distribution in multifield therapy is indicated. (auth)

40932 DOSE SENSITIVITY OF A RHODIUM NEUTRON DETECTOR. Obaturov, G. M.; Chumbarov, Yu. K. This paper was summarized in At. Energ. (USSR); 30: No. 4, 387(Apr 1971) as paper No. 483/5783. (In Russian).

Full copy of this paper is held by TIC.

The average value of the dose sensitivity (barns · neutrons/cm^2 · rad) of a ^{103}Rh activation detector was calculated to investigate its possible use for neutron dosimetry. Calculations were performed for various neutron spectra in the energy ranges of 0.4 eV to 10 MeV and 0.45 to 10 MeV. The results of the calculations are presented, and it is concluded that dose can be measured with a rhodium detector to an accuracy which is acceptable in practice, particularly if the shield material is known. The lower limit of the measurements is ~1 rad. (W.H.K.)

40933 AUTOMATIC SELECTIONING APPARATUS. Duport, Philippe; Esbach, Michel; Marchal, Paul; Portal, Guy (to Commissariat a l'Energie Atomique). French Patent 2,076,285. 20 Sep 1971. Filed 8 Jan 1970. (In French).

An automatic selectioning apparatus, which enables a series of personnel dosimeter films to be divided into groups, depending upon the apparent quantity of irradiation each has received, is described. A special system successively brings the dosimeters to a nondestructive reading device (eg a photometer), which compares the irradiation received by these dosimeters with a reference threshold corresponding to the minimum value of irradiation judged to be significant. The selectioning and comparing apparatus directs the dosimeters having received nonsignificant doses to a place where they are stored. (France)

40934 PRESENTATION AND DISCUSSION OF A PHOTOGRAPHIC DOSIMETRY METHOD. Milanesi, Renato; Menin, Alessandro; Puppini, Gianni; Pasoli, Armando (Istituti Ospitalieri, Verona, Italy). Radiol. Med.; 57: No. 10, 769-77 (Oct 1971). (In Italian).

A description is given of a photographic method designed for the cheap and rapid production of isodose curves from sensitive films exposed to ionizing radiations. The photographic contrast theory, forming the basis of the method, is discussed in terms of its physical, chemical, and analytical features. (auth)

40935 THERMOLUMINESCENCE (LiF) DOSIMETERS IN THE DOSIMETRY OF 5 TO 42 MeV ELECTRON BEAMS. Rovera, Sergio (Univ., Pavia, Italy); Coucourde, Francesco; Cereda, Bruno; (and others). Radiol. Med.; 57: No. 10, 758-68(Oct 1971). (In Italian).

Satisfactory linearity and reproducibility was observed with LiF thermoluminescence dosimeters experimented with a view to their use in the dosimetry of 5 to 12 MeV electron beams at doses of the order of 10^2 rad. (auth)

40936 DETERMINATION AND DISTRIBUTION OF THE BETA RADIATION ABSORBED DOSE UNIT RAD BY THE DEUTSCHES AMT FUER MESSWESEN UND WARENPRUEFUNG. PART I. CONSTRUCTION AND FUNCTION OF THE EXTRAPOLATION IONIZATION CHAMBER AND OF THE IRRADIATION PLANT. Guehne, F.; Helmstaedter, K. (Deutsches Amt fuer Messwesen und Warenpruefung, Berlin). Isotopenpraxis; 8: No. 2, 47-52(Feb 1972). (In German).

A standard measuring device for the determination and distribution of the beta radiation absorbed dose unit "rad", comprising an extrapolation ionization chamber, a beta-ray scintillation spectrometer as primary normal, a set of flat-type ionization chambers of various dimensions as secondary normals, and an irradiation plant, which has been made by the Deutsches Amt für Messwesen und Warenprüfung, is reported. The first part of the report deals with the construction and the function of both the extrapolation ionization chamber and the irradiation plant, having in view the particular business of the DAMW, such as the determination of units both for medical therapy and for radiation protection purpose. The extrapolation ionization chamber provides absolute measurement of absorbed dose rates for beta irradiation of tissue-equivalent material ranging from 200 mrd/h up to 2 · 10^4 rd/h, measuring accuracy being ±5 percent. (auth)

40937 PORTABLE NEUTRON-IRRADIATION APPARATUS. Andreev, V. K.; Egiazarov, B. G.; Korytko, L. A.; Sel'dyakov, Yu. P. This paper was summarized in At. Energ. (USSR); 31: No. 2, 140(Aug 1971) as paper No. 520/6148. (In Russian).

Full copy of this paper is held by TIC.

A portable pulsed neutron-irradiation apparatus is described which can carry out the following tasks in the case of natural rock formations: 1) spectrometry of the natural γ-radiation, 2) spectrometry of the γ-radiation from inelastic scattering of fast neutrons (ISFN), 3) spectrometry of the γ-radiation from the radiative capture of neutrons (GRCN), 4) measurement of the temporal distribution of captured γ-radiation, and 5) spectrometry of the induced-activity γ-radiation (IAG) in two situations—during and after irradiation of the medium by means of a pulsed neutron source (for relatively short-lived isotopes). The apparatus consists of a remote unit containing a pulsed neutron source and a scintillation detector, a control and synchronization unit, and a recording device (a pulse analyzer). The pulsed neutron source provides a neutron output of up to 10^7 neutrons/sec at a pulse repetition frequency of 500-10,000 Hz, and a pulse length of 5-10 μsec. The neutron source may operate continuously. The control and synchronization unit detects γ-radiation during specified time intervals and synchronizes the operation of the apparatus at the various stages of the measurement. Amplitude-to-time pulse analyzers may be used as recorders. The apparatus weighs about 12 kg (without the recorder), and it draws no more than 20 W. The remote unit is 110 mm in diameter and 1300 mm long. Experimental results illustrating the operation of the apparatus and its capabilities for directly determining the coal content (with a bore model) and the content of the basic rock-forming elements are presented. The results of measurements with a semiconductor γ-detector are also reported. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 40612 and 40618

40938 (JINR-P13-6427) SCINTILLATION SINGLE-CRYSTAL TIME SPECTROMETER. Morozov, V. A.; Muminov, T. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). May 1972. 7p. (In Russian). Dep. NTIS (U. S. Sales Only).

A method of searching for the isomeric ($T_{1/2}$ > 10 nsec) levels in short-lived radioactive nuclei using a single-crystal scintillation spectrometer with a plastic scintillator is suggested. The spectrometer was designed at the Laboratory of Nuclear Physics. (auth)

40939 (KFK-1480) POTENTIAL OF ADVANCED GAMMA-RAY SPECTROMETERS FOR NUCLEAR MATERIAL ASSAY. Michaelis, W.; Weitkamp, C. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Aug 1971. 27p. (CONF-710824-3). Dep. NTIS (U. S. Sales Only).

From Meeting on the development of gamma spectrometry instrumentation and techniques for safeguards; Vienna, Austria (30 Aug 1971).

Cost-effectiveness optimization for the application of Compton suppression techniques in nondestructive nuclear material assay requires quantification of the basic spectroscopic parameters. The influence of peak-to-background ratio and window setting and some aspects of data processing are studied in detail. The results are applied to typical spectra at various stages of the fuel cycle. It turns out that in the case of unirradiated fuel there is no need for the use of anti-Compton devices for the determination of ^{235}U in plutonium-free fuel, of ^{238}U and of ^{239}Pu. The technique is, however, most useful in the assay of ^{235}U in mixed U-Pu fuel and in the determination of plutonium isotopes other than ^{239}Pu. Considerable advantages are also offered in gamma spectrometry on spent fuel and in the analysis of delayed spectra from active neutron interrogation. The capabilities of Compton rejection spectrometry may be used either to shorten the counting time or improve statistical accuracy, or to reduce count-rate losses. Detectors from high-Z material may compete with germanium detectors even if the high-Z detectors do not match volume and resolution specifications of germanium. (auth)

40940 (SC-RR-710490) DETECTION OF HIGH EXPLOSIVES FROM ANALYSIS OF CAPTURE GAMMA RADIATION. Halbleib, J. A.; Vandevender, W. H. (Sandia Labs., Albuquerque, N. Mex.). Aug 1971. 28p. Dep. NTIS.

A limited theoretical study of the response of several detectors to capture gamma radiation is presented, and the feasibility of detecting the presence of high explosives just below ground level from the analysis of the capture gamma ray response of a particular array of NE316 scintillation detectors is discussed. (auth)

40941 STATISTICAL ERRORS IN MONOENERGETIC NUCLEAR RADIATION MEASUREMENTS. Daddi, L. (Univ., Pisa, Italy). Minerva Fisiconucl.; 15: No. 3, 135-8(Jul-Sep 1971). (In Italian).

The origin and extent of statistical errors deduced from the observations of high-energy peaks due to monoenergetic nuclear radiations are discussed. General criteria for the suppression of such errors are also presented. (auth)

40942 X-RAY FLUORESCENCE SPECTROMETRY USING Au–nSi DIODES. Cassanhiol, B.; Peyre-Lavigne, A.; Peyre-Lavigne, M.; Malmary, A. M. pp 79-82 of Second International Conference on X Ray Analytical Methods. Issy-les-Moulineaux, France; Compagnie Generale de Radiologie (1971). (In French).

From International conference on x ray analytical methods; Toulouse, France (6 Sep 1971). See CONF-710937.

A brief description is given of the Au–nSi diode developed, the electrical parameters which characterize the barrier metal–semiconductor junction being in agreement with theoretical calculations. Using this sort of structure amplification coefficients (M) of the order of 10 can be obtained. Such high values of M are accompanied by undesirably high currents. (France)

40943 COMPUTER ANALYSIS OF COMPLEX GAMMA SPECTRA. Rangarajan, C. (Bhabha Atomic Research Centre, Trombay, India). pp 557-67 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

The analysis of complex gamma spectra consists in the determination of the counts due to each specific isotope present in the source from the measured spectrum which is the result of the contribution from all the isotopes. From the separated count rates, the specific isotopes can be determined with the help of standard sources. This process of "unscrambling" the gamma spectrum can be carried out by, (a) the method of simultaneous equations, and (b) least squares analysis. The use of the two methods are described and results of several experiments carried out to test the accuracy of the analysis under various conditions are discussed. (auth)

40944 DOUBLE-FOCUSING MAGNETIC BETA-RAY SPECTROMETER. Sahoo, H. K.; Misra, S. C.; Gupta, U. C. (Bhabha Atomic Research Centre, Trombay, India). pp 595-600 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

The principle and the design of a double focusing magnetic beta-ray spectrometer of $\pi\sqrt{2}$ type is described. The double focusing field has been obtained using conical iron pole faces. The field distribution in and around the pole gap has been measured and the data have been used to improve the linearity and the radial extent of the double focusing field form by further shaping the pole pieces. The spectrometer has a radius of 12.7 cm and a momentum resolution (F.W.H.M.) of 0.5% at a transmission of 0.05%. The energy range is from 100 keV to 2.4 MeV which covers the beta-rays and the conversion electrons emitted by most of the commonly used radioisotopes. (auth)

40945 Si(Li) X-RAY SPECTROMETER WITH <1 keV RESOLUTION. Bacso, Jozef; Lakatos, Tamas. ATOMKI (At. Kut. Intez.) Kozlem.; 13: No. 3, 107-14(Nov 1971). (In Hungarian).

The description of a Si(Li) detector and charge-sensitive preamplifier system developed in ATOMKI is given. The resolution of the system is <1 keV (fwhm) at the x-ray energy of 13.94 keV (with cooled detector and preamplifier). (6 figures) (auth)

40946 PERFORMANCE OF PLASTIC SCINTILLATORS. Kang, Young-ho; Lee, Sahng-yun (Kyungpook National Univ., Taikyu, S. Korea). New Phys. (S. Korea); 11: No. 3, 97-103 (Sep 1971). (In Korean).

The performance of plastic scintillators was studied. The characteristics of the plastic scintillators, made by polymerization of various monomers, are described. As the monomer, n-butyl methacrylate, vinyltoluene, or styrene was used. P-terphenyl and PPO were used as the primary phosphor, and POPOP was used as the secondary phosphor added to the monomer. Compared with the inorganic scintillator, the plastic scintillator has great difficulty in analyzing the energy of nuclides, and its background counting rate is nearly proportional to the thickness of the plastic scintillator. The minimum detectable amount for ^{90}Sr of this scintillator was 0.12 to 0.15 nCi. Furthermore, the probe of the scintillation detector was also made, and it was found that the production of plastic scintillation detectors in the laboratory was feasible. (10 figures, 4 tables) (auth)

40947 RESONANCE DETECTOR FOR ^{119}Sn WITH WINDOWLESS ELECTRON MULTIPLIER. Kamenov, P.; Jordanova, R.; Vapirev, E.; Gourev, V. Rev. Roum. Phys.; 17: No. 3, 309-12(1972).

A description of the construction of a resonance Mössbauer detector for ^{119}Sn with windowless electron multiplier is given. The electron multiplier is put in a special vacuum cylinder, and registers the conversion electrons from the sample investigated. The sample is put in the vacuum cylinder, and the gamma rays are let in through a window closed with a thin aluminum foil. The main advantage of the resonance detector is that a comparatively narrow line is obtained, the ratio between signal and noise is great, and the study of thin layers is possible. (2 figures) (auth)

High Energy Physics Instrumentation

Refer also to abstracts 41746, 41808, 41809, 41880, and 42001.

40948 (ANL–7934) PROCEEDINGS OF THE INFORMAL COLLOQUIUM ON POLLY AND POLLY-LIKE DEVICES, JANUARY 11 AND 12, 1972. Kosner, Carol (ed.) (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 214p. (CONF-720116). Dep. NTIS.

Separate abstracts were prepared for the 23 papers presented. (W.H.K.)

For abstracts of individual papers see: 40949–40971.

40949 (ANL–7934, pp 4-21) STATUS REPORT ON THE ANL POLLY SYSTEM. Beck, F.; Charlton, G.; Engelmann, R.; Marema, R.; Musgrave, B.; Peeters, P.; Phillips, B.; Thelen, G.; Zieman, B. (Argonne National Lab., Ill.). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

Two cathode ray tube systems, POLLY II and POLLY III, are in operation at ANL. POLLY II is measuring bubble chamber photographs from the 30" MURA bubble chamber. POLLY III was built to process film from the ANL 12 foot bubble chamber. Production measurements on the 12 GeV/c pp film have begun. Considerable effort is being made in improving the POLLY III software in order to increase measuring speed and quality. A XDS Σ7 computer controls one of the two installations at a time. (auth)

40950 (ANL–7934, pp 22-6) POLLY III TRACK DISCRIMINATOR. Phillips, H. B. (Argonne National Lab., Ill.). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

A new track discriminator circuit has been tested on the bench using POLLY-like signals. The new circuit, as does the previous one, uses information obtained during each sweep to set the discriminator level for the following sweep. (auth)

40951 (ANL–7934, pp 27-36) COCCINELLE: 4 VIEW FILM TRANSPORT. Equer, B.; Fontaine, G.; Marchand, D. (College de France, Paris. Laboratoire de Physique Nucleaire). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

Progress on COCCINELLE, a CRT device for large bubble chambers, is described. The four view film transport, which is of an unusual design, is described together with the reasons for choosing this design. (auth)

40952 (ANL–7934, pp 37-40) CARNEGIE-MELLON UNIVERSITY–CASE WESTERN RESERVE UNIVERSITY POLLY. Kikuchi, Tadashi (Carnegie-Mellon Univ., Pittsburgh, Pa.). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

Progress on a joint project by Carnegie–Mellon University and Case Western Reserve University in construction of a POLLY III system is outlined. Approximately ninety percent of the machine has been fabricated and assembled. It is hoped to have a simple measuring system by late spring, 1972. (auth)

40953 (ANL-7934, pp 41-7) UNIVERSITY OF ILLINOIS DOLLY HARDWARE. Downing, R. W.; Simaitis, J.; Zander, D. (Illinois Univ., Urbana). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

DOLLY is a precision multiple film CRT film measuring machine similar to POLLY, however, by the use of digital hardware a more flexible slice scan may be generated. The arithmetic unit, D/A converter, and optical system are discussed. (auth)

40954 (ANL-7934, pp 48-60) SOME SOFTWARE TECHNIQUES FOR THE DOLLY SYSTEM. Brown, Richard M.; Wray, Jerald J. (Illinois Univ., Urbana). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

The use of histogram techniques for pattern recognition and filtering is discussed. Also described is an interpretive sequencer used to control both complex measuring sequences and detailed scanning procedures. (auth)

40955 (ANL-7934, pp 61-6) PURDUE POLLY: STATUS REPORT. McIlwain, R. L.; Ammann, A. C.; Buten, R. E.; Loeffler, F. J.; Olive, D. F.; Palfrey, T. R. Jr.; Rangan, K. L.; Shrimplin, M. W. (Purdue Univ., Lafayette, Ind. Dept. of Physics). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

The present status and distinctive design features of the Purdue POLLY are described. Software and hardware layout and status are presented separately. (auth)

40956 (ANL-7934, pp 67-76) MICROPROGRAMMED POLLY CONTROLLER. McIlwain, R. L. (Purdue Univ., Lafayette, Ind. Dept. of Physics). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

A microprogrammed controller for a POLLY automatic measuring machine is described. It offers great flexibility in sweep generation and data collection. (auth)

40957 (ANL-7934, pp 77-81) GENERAL DESCRIPTION OF THE AMES LABORATORY POLLY. Birlingmair, D.; Fellinger, M.; Fullhart, C.; Haxby, R.; Kernan, W.; Varga, H. (Ames Lab., Iowa). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

A general description of the Ames Lab. POLLY system (called "HOLLY" for various obscure reasons) is given, including reasons for choosing specific components. The present status of the hardware is that one bay is operating well enough to test the software. Plans for the future are also discussed. (auth)

40958 (ANL-7934, pp 82-6) AMES LABORATORY INTERACTIVE HARDWARE PROGRAMMED POLLY. Thomas, William D. (Ames Lab., Iowa). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

Operational concepts concerning the amount of computer control required to select, gather, and display data in a POLLY system are presented. An attempt is made to minimize computer interaction by incorporating outboard parallel processing function controllers. These function controllers are hardwired program subroutines to which the main software program can pass the desired parameters. Necessary system status information is presented to the operator through a lighted panel as well as a video display. A built-in computer simulator is used to facilitate checkout and maintenance. Logic design of the digital controllers and video display are discussed. (auth)

40959 (ANL-7934, pp 87-96) AMES LABORATORY HOLLY PROGRAMMING SYSTEM. Higby, W. J.; Klein, Arthur H. (Ames Lab., Iowa). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

This paper presents some of the program development done in connection with the automatic "POLLY-like" measuring system. Some features of the program overlay supervisor for a small computer are discussed. The operator CRT display system includes a control interface designed and built at Iowa State University and a computer controlled display file refresh logic. The bulk of software event measuring logic consists of the POLLY FORTRAN programming done by the staff at Argonne National Laboratory. (auth)

40960 (ANL-7934, pp 97-107) MOLLY: A PROGRESS REPORT. Lippmann, Roy A.; Slater, Wm E. (California Univ., Los Angeles. Dept. of Physics). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

Progress is described on the building and testing of the basic components of a POLLY type automatic scanning and measuring machine, to wit: CRT yoke mounts and controls, optical frame, and Digital to Analog Converter. The DAC is free of oscillation, settles in 12 μsec, and is linear over times of the order of weeks. The CRT spot, focussed on a film platen, shows a full width at half maximum intensity of 14 μ at center screen and 20 μ at the edge. (auth)

40961 (ANL-7934, pp 108-14) STATUS OF NAL SAMM. Bogert, D.; Cavanaugh, R.; Chrisman, B.; Hanft, R.; Johnson, G. (National Accelerator Lab., Batavia, Ill.). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

SAMM is an abbreviation for Semi-Automatic Measuring Machine. The basic design of the NAL machine, progress on the construction of the NAL SAMM to date, and some of the reasons behind the choice of the particular designs utilized in this machine are discussed. (auth)

40962 (ANL-7934, pp 115-24) NAL SIMULATOR. Chrisman, B. L. (National Accelerator Lab., Batavia, Ill.). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

As part of the NAL program to develop a Semi-Automatic Measuring Machine (SAMM), a film and hardware simulator has been written. The simulator has two distinct functions: it sets up equations defining tracks and events on film, and it simulates the slice scan desired and returns the information on hits and misses. The software was adapted from the Argonne POLLY programs. (W.H.K.)

40963 (ANL-7934, pp 129-40) PROGRESS REPORT ON THE BNL VERTEX GUIDANCE SYSTEM. Connolly, Philip L. (Brookhaven National Lab., Upton, N. Y.). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

The bubble chamber film is scanned and vertices rough-digitized at tables connected on-line to an XDS Sigma 7. Accurate digitizing is done by the single-view HPD controlled by an IBM 7094. Tracks are initiated, followed and reconstructed in 3 views by programs operating in a CDC 6600. If errors are detected by the 6600 programs, the data are transferred to the Sigma 7 where a human operator, utilizing a TV display and tracking programs in the Sigma 7, can repair any deficiencies. In some months the HPD will be replaced by a Flying Image Digitizer connected to both the Sigma 7 and the 6600. (auth)

40964 (ANL-7934, pp 141-8) BRUSSELS ON-LINE SYSTEM-BROL PROGRESS REPORT. Lemonne, J.; Van Binst, P. (Brussels Univ. (Belgium)). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

The design of an integrated on-line system for the analysis of film from giant bubble chambers is described. This system is built around a PDP-10 computer and is intended to simultaneously support both automatic (POLLY-III) and manual devices. The reasons for the choice of the computer are briefly mentioned. (auth)

40965 (ANL-7934, pp 149-59) ALICE: A GENERAL-PURPOSE IMAGE PROCESSING SYSTEM. Butler, J. W.; Haasl, J. R.; Hodges, D.; Kroupa, B.; Shelman, C. B.; Wehman, R. H. (Argonne National Lab., Ill.). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

A general-purpose image processing system, ALICE, is described. A large influence in the system design was the concept of interaction between machine and human operator in simple yet convenient ways. Furthermore, the incorporation of a medium-sized computer (a PDP-10 with 32K core memory) allows significant data processing to occur while the image source is still available. The system is built in an open-ended manner so that a variety of image sources can easily be attached to the scanner controller interface. Currently, two film stations and an optical microscope are operating. (auth)

40966 (ANL-7934, pp 160-71) UNIVERSITY OF TORONTO POLLY PROGRESS REPORT. Phillips, J. S. (Toronto Univ. (Ontario). Dept. of Physics). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

The University of Toronto has ordered the first commercial POLLY, conforming to the ANL POLLY III specifications from SEACO, to be used to measure bubble chamber pictures and also large quantities of pictures generated in medical cell biology and chemical engineering research. Delivery is scheduled for mid-January. A PDP-10 control computer has already been installed.

Progress with the hardware and conversion of the software based on PONG 83 are described. (auth)

40967 (ANL–7934, pp 172-7) APPLICATIONS OF POLLY TO BIOLOGY AND HYDRODYNAMICS. West, Edmund C. (Toronto Univ. (Ontario). Dept. of Physics). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

The POLLY installation at the University of Toronto will be shared among the High Energy Physics group, which will be involved in the measurement of bubble chamber film, and two users from the departments of Chemical Engineering and Medical Cell Biology. The biological application of POLLY will be the analysis of electron micrographs of DNA molecules. Also, the measurement of certain flow properties of confined fluids, which is being undertaken by a chemical engineering group, will use the POLLY system very extensively. (auth)

40968 (ANL–7934, pp 178-85) CALTECH POLLY: STATUS REPORT. Dzierba, Alex; Gomez, Ricardo; Oddone, Piermaria; Power, John; Sedleniek, Sven; Sell, Dan; Tollestrup, Alvin (California Inst. of Tech., Pasadena (USA). Charles C. Lauritsen Lab. of High Energy Physics). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

Topics include considerations that led to the mechanical and optical layout; description and performance of the various subsystems (measuring CRT, view selection, film transport, optical pointer, operator displays, etc.); the electronic control of POLLY; and the computer configuration (task assignment and communication between the PDP-11 and PDP-10 computer). (auth)

40969 (ANL–7934, pp 186-94) TRANSIENT ANALYSIS OF DEFLECTION AND PHOTOMULTIPLIER CIRCUITS. Power, John (California Inst. of Tech., Pasadena). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

The transient response of CRT flying spot scanners is discussed in two separate contexts. Deflection circuit settling time is related to external capacitive loading, leading to the design used in the CIT POLLY, in which the deflection switches and current generators are physically separated. Signal-to-noise ratio in the photomultiplier is analyzed for the purpose of choosing the best time constant for filtering the signal. Results indicate that a smaller aperture, and hence less expensive, measuring lens can be used. (auth)

40970 (ANL–7934, pp 195-9) PROGRESS REPORT ON THE UNIVERSITY OF MICHIGAN CRT MEASURING EQUIPMENT. Chapman, J. W. (Michigan Univ., Ann Arbor. Harrison M. Randall Lab. of Physics). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

Progress on the construction of a CRT scanner patterned after the ANL POLLY III and the University of Illinois DOLLY is discussed. The connection of the scanner to the Honeywell model 124 computer is presented along with two features of the system that are specific to the Michigan scanner. (auth)

40971 (ANL–7934, pp 200-7) LENS RESOLUTION VERSUS FIELD AS APPLIED TO THE POLLY PROGRAM. Steele, R. K. (SEACO Computer-Display Inc., Garland, Tex.). 1972.

From Informal conference on Polly and Polly-like devices; Argonne, Il. (11 Jan 1972).

Topics include the conversion of a spot size requirement into an MTF requirement, resolution versus field size, and specific film formats with respect to lens magnifications for the POLLY III programs. (W.H.K.)

40972 (CEA-R-4329) METHOD FOR THE AUTOMATIC RECOGNITION OF EVENTS FROM BUBBLE CHAMBER PHOTOGRAPHS. Villeneuve de Janti, Philippe (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr 1972. 238p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ. (France).

A new method for automatic scanning of bubble chamber films is proposed. Its main feature consists of using a specialized optical system for detecting information points as vertices, then allowing a fast image analysis which does not need a big computer. A simplified prototype has been built and systematically tested. The main features and limits of the operational device are presented. (auth)

40973 (LA-tr–72-18) ACHROMATIC CHERENKOV COUNTER WITH A CALCULATED RESOLUTION OF ± MeV FOR PROTONS OF ENERGY 400 TO 700 MeV. Zrelov, V. P.; Kollar, D.; Pavlovich, P.; Ruzhichka, Ia.; Shulek, P. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from pp 482-5 of report JINR–D-5805. 5p. (CONF-700902–9). Dep. NTIS.

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

An achromatic Cherenkov counter, developed to study the quasi-elastic scattering of 660-MeV protons on light nuclei, is described. Data characterizing the degree of achromatization for the wavelength extremes from 365.0 to 656.3 nm are tabulated. (W.H.K.)

40974 (SLAC–144, pp 12.1-15) PHYSICS WITH THE 12' BUBBLE CHAMBER. Derrick, M. (Argonne National Lab., Ill.). Mar 1972.

From Joint Japanese–U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

The present status and future plans for physics experiments using the 12-foot hydrogen bubble chamber are discussed. The design features, thermodynamic considerations, aspect ratio, particle trapping, secondary interactions, and setting accuracies of the chamber are covered. Also the experimental program for strong and weak interactions is briefly mentioned. (J.F.P.)

40975 (SLAC–144, pp 20.1-15) PRESENT STATUS OF BUBBLE CHAMBERS IN THE U. S. Ballam, J. (Stanford Linear Accelerator Center, Calif.). Mar 1972.

From Joint Japanese–U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

The efficiency of U. S. bubble chambers for picture taking and the data analysis capability for these detectors is discussed. Also the status of strong interactions in bubble chambers at SLAC, ANL, and BNL is briefly given. (J.F.P.)

40976 TRANSDUCERS. PIEZOELECTRIC DETECTION OF TORSIONAL WAVES IN WIRE SPARK CHAMBERS. Juach, K. M.; Bichara, M. R. E. (Univ., Geneva). Compt. Rend., Ser. B; 274: No. 8, 559-61(21 Feb 1972). (In French).

A new device for the piezoelectric detection of torsional waves is described. Formulas for the geometric form and relative output voltage are given. The experiments demonstrate a large improvement in relation to previous methods (magnetostriction) of determining the trajectories of particle beams in wire spark chambers. (France)

40977 CALIBRATION CF A SPARK CALORIMETER WITH PIONS OF ENERGIES 27 TO 65 GeV. Alakoz, A. V.; Vasil'eva, L. F.; Vasil'ev, P. S.; (and others) (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2176-9 (Oct 1971). (In Russian).

A "spark calorimeter" consisting of eight spark chambers interleaved with iron filters was calibrated with pions having energies in the range 27 to 65 GeV. Its most important feature is its energy resolution, and experience has shown that hadron energy in the range 20 to 100 GeV may be measured with an accuracy of ~20%. (K.S.W.)

40978 MEASUREMENT OF IONIZATION IN THE REGION OF LOGARITHMIC GROWTH. Kim, V. M.; Kotel'nikov, K. A.; Puchkov, V. S. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2180-2(Oct 1971). (In Russian).

The Tyan-Shan' installation originally used for studying nucleon–nucleon interactions in cosmic rays was complemented by the addition of an overhead Wilson chamber 600 liters in volume and filled with a 50/50 Ar–He mixture with added alcohol/water vapor. A pulsed lamp (15 joule sparks) was used to illuminate the traces for photography. Measurement of μ-meson tracks provided an experimental relation between ionization and the value $\beta\gamma$ in the region of logarithmic growth for a given gas mixture. (K.S.W.)

Radiometric Instruments

Refer also to abstract 41525.

40979 DENSITY LOGGING IN BORE HOLES USING GAMMA-BACKSCATTER TECHNIQUE. Atal, B. S.; Rai, Lajpat; Bhatnagar, A. S. (Dept. of Atomic Energy, New Delhi). pp 623-9 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

A precision density logging probe, based on the gamma-backscatter technique using a 3.5 mCi ^{137}Cs source and a GM tube as detector, has been developed and calibrated for logging AX size (46 mm dia) bore holes. Response curves with charge in density for different source to detector distances are plotted. The density gage is optimized at a source to detector distance of 7'' for minimum response to change in the matrix of the soil and water content. This has been achieved by taking advantage of the poor response of the GM tube to the gamma energies below 0.3 MeV and lower when housed in $^{1}/_{16}$'' brass probe casing, thereby minimizing the soil type effects which appear because of photo-electric absorption becoming important at lower energies. The density probe has built-in EHT and impendance matching circuitry with decade interpolation. It is simple in design, reliable, has good temperature stability and is capable of logging 4000 ft. (1200 m) deep bore holes from EX size (36 mm dia) onwards. A method for reducing the temperature sensitivity of the density probe using a scintillation counter is also suggested. (auth)

40980 BETA-RAY THICKNESS GAUGE USING A TWO ENERGY LEVEL BETA-RAY SOURCE. Cahill, Bonaventure B.; Lyon, Wilfred W. (to Ohmart Corp.). U. S. Patent 3,665,199. 23 May 1972. Filed 10 Nov 1969.

A beta gage for measuring the thickness of material over an extended range, for example, 0 to 750 mg/cm^2, is described. The gage includes a first cell containing gaseous low-energy-beta-emitting ^{85}Kr and has a first window adjacent an air gap in which the specimen to be measured is located and a second window opposite this. A second cell containing high-energy-beta-emitting ^{90}Sr/^{90}Y is located adjacent the krypton cell on the side opposite the air gap, and has a third window aligned with the first and second windows of the krypton cell through which beta radiation from the ^{90}Sr/^{90}Y passes along a path to the specimen. This path includes also the first and second windows of the krypton cell as well as the krypton itself. (auth)

40981 NUCLEAR GAUGE CHECKS CHIP MOISTURE. Can. Chem. Process.; 56: No. 3, 53-4(Mar 1972).

A nuclear moisture gage which precisely determines free moisture of wood chips on-line was originated by a West German firm, Laboratorium Prof. Dr. Berthold. Neutrons and gamma rays are emitted from radioactive sources (241-Am-Be and 137-Cs), interact with nearby atoms, and the reflected neutrons and gammas are detected by a LiI sensor to yield a signal which corresponds to the free moisture content of the material passing the gage. A key advantage of the nuclear gauge is that its readout is independent of the temperature and physical state of the matter under test. (Canada)

40982 EQUIPMENT FOR MEASURING THE THICKNESS OF A THIN FILM OF HYDROGENATED MATTER USING THE SLOWING DOWN OF NEUTRONS. Baron, Jean Pierre (to Etat Francais. Ministere de l'Equipement et du Logement. Laboratoire Central des Ponts et Chaussees). French Patent 2,079,926. 18 Oct 1971. Filed 17 Feb 1970. (In French).

Equipment for measuring the thickness of a thin film (0 to 5 mm) of hydrogenated matter (in particular the thickness of a film of water on a road surface) is described. This equipment utilizes a fast neutron source buried in a mass of moderator material and situated at a predetermined distance from a reference plane on which the water film exists. An appropriate device for detecting and counting the neutrons slowed down by the thin film is provided. The moderator layer is such that the energy of the slowed down neutrons lies between 0.03 and 1 keV (thermal). (France)

Radiation Effects on Instrument Components, Instruments, and Electronic Systems

40983 EFFECT OF NEUTRON AND γ RADIATION ON THE POTENTIAL OF REFERENCE ELECTRODES. Krast, Kh. B.; Byalobzheskii, A. V.; Lepin, L. K.; Kadek, V. M. (Inst. of Inorganic Chemistry, Riga). Latv. PSR Zinat. Akad. Vestis; No. 10, 127-9(1971). (In Russian).

The lack of information concerning the reliability of reference electrodes exposed to radiation greatly hindered the study of metals in operating reactors; in particular, the insertion of electrodes by means of liquid contact, as in case of the calomel reference electrode, complicates the design of in-pile electrochemical experiments. To avoid problems posed by the liquid contact, AgCl electrode which can be connected directed to the experimental cell was used for the study. The stability of the potential of the electrochemical cells was determined by exposing the electrodes to a neutron flux of 1.25×10^{12} n/cm^2-s and a γ radiation of 650 rad/s in the beamhole of the IRT-2000 reactor. The temperature of the cell was controlled during the experiment. Similar tests were carried out in the absence of radiation. It was found that the temperature coefficient of the 0.001N KCl–AgCl electrode is 0.92 mV/°C; the isothermal coefficients of the AgCl and calomel reference electrodes were calculated at −0.27 and 0.05 mV/°C; respectively. The temperature coefficient must be taken into account when the electrode is exposed to such a radiation field. The chief shortcoming of the calomel reference electrode is the high activation cross section of Hg, which causes heating up of the system; this can be partially remedied by using a Cd foil envelope. (TTT)

Miscellaneous Instruments and Components

Refer also to abstracts 41063, 41682, 42517, 42600, and 42606.

40984 (CEA-N-1516) GENERATOR OF EXTENDED DURATION HIGH VOLTAGE PULSES. Gaucher, Jean-Claude; Roux, Georges (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb 1972. 18p. (In French). Dep. NTIS (U. S. Sales Only).

A generator of high-voltage extended-duration pulses was developed to control a high-gain light amplifier used to provide a visual display of low-energy γ radiation. The pulse amplitude is 1500 volts with a 100 pF capacitive load. The rise time with this load is 50 ns with a 50 ns trigger delay. The pulse duration may be adjusted between 70 and 450 microseconds. The high voltage supply consumes 1 mA. (France)

40985 (TID-25876) CAMAC: ORGANIZATION OF MULTI-CRATE SYSTEM. Costrell, Louis (ed.) (Atomic Energy Commission, Washington, D. C.). Mar 1972. 48p. GPO $0.60.

CAMAC is a design for modular equipment systems used on-line with digital processors and computers and incorporates a comprehensive data transfer highway (Dataway). This extension to the CAMAC specifications defines a Branch Highway and a standard Crate Controller for communication between a system controller or computer and as many as seven crates. The specification has been developed by the ESONE Committee of European Laboratories and has been endorsed by the USAEC Committee on Nuclear Instrument Modules (NIM Committee). Except for introductory material and the NIM Committee listing, this report is identical to Euratom Report EUR 4600e dated October 1971. AEC Report TID-25877 constitutes a supplement to and is to be used in conjunction with this report. The basic CAMAC specifications are defined in AEC Report TID-25875. (auth)

40986 THREE-JOSEPHSON-JUNCTION INTERFEROMETER. Stuehm, D. L.; Wilmsen, C. W. (Colorado State Univ., Fort Collins). Appl. Phys. Lett.; 20: No. 11, 456-8(1 Jun 1972).

The three-Josephson-junction asymmetric-feed quantum interferometer was analyzed and shown to have increased magnetic field sensitivity and amplitude deviation over the two-junction interferometer. The critical current at zero applied field is shown to be less than the critical current at zero flux in the interference loop. (auth)

40987 AUTOMATION OF A UNIVERSAL X-RAY FLUORESCENCE SPECTROMETER. Sahores, J. (Societe Nationale des Petroles d'Aquitaine, Pau, France). pp 89-92 of Second International Conference on X Ray Analytical Methods. Issy-les-Moulineaux, France; Compagnie Generale de Radiologie (1971). (In French).

From International conference on x ray analytical methods; Toulouse, France (6 Sep 1971). See CONF-710937.

An automatic sample selector, suitable for use in conjunction with a spectrometer, is described. The device operates without mechanical shocks, thus permitting the analysis of a variety of different forms of material: noncompact or compact powder deposited on a mylar support, thin films, pearl and pellet shaped samples, and liquids. (France)

40988 ION SCATTERING SPECTROMETER WITH NEUTRALIZATION. Goff, Robert F. (to Minnesota Mining and Mfg. Co.). U. S. Patent 3,665,185. 23 May 1972. Filed 19 Oct 1970.

An ion scattering spectrometer for elemental surface analysis comprising an ion generator, an energy analyzer, an ion detector, an indicating apparatus, and a closed-loop feedback device for neutralizing an electrically non-conductive target is described. (auth)

40989 EVALUATION OF RADIATION HAZARDS FROM HIGH-VOLTAGE VACUUM INTERRUPTERS. Greenhouse, N. A. (Brookhaven National Lab., Upton, N. Y.); Peterson, G. C. Health Phys.; 23: No. 1, 85-8(Jul 1972).

High-voltage vacuum interrupters are electro-mechanical relays frequently used to control dc, ac and rf currents at potentials up to about 100 kV. With high potential differences impressed across the open electrodes these devices can become potent x-ray generators. The principal source of x-rays is apparently field-emission of electrons from the cathode. Additional electrons may be produced by ionization of residual gas and subsequent ion bombardment of the cathode. X-ray fields of the order of tens of roentgens per hour at 1 m were produced from interrupters operated within their maximum voltage rating. The production of x-rays is correlated with electrode condition and alignment, gap distance and envelope pressure. (auth) (UK)

40990 WINDING TYPE ELECTROMAGNETIC FLOWMETERS FOR METALLIC SODIUM. Amano, Ken-ichi (Meidensha Electric Mfg. Co. Ltd., Tokyo). Meidensha Jiho; No. 100, 14-18(Oct 1971). (In Japanese).

Alumite wires were employed as the exciting coil windings since sodium is exposed to temperatures up to approximately 600°C and sometimes is radioactive. Calibration of the flowmeters was conducted by a volumetric method in the sodium research laboratory of JAERI, resulting in good performance. Several problems must be solved such as the theoretical calibration of the flux density in the large size meters, more heat-resistant material than alumite, and noise rejection in the case of high currents in sodium. (Japan)

40991 NEUTRON DIFFRACTION FACILITIES. Moore, F. H. (Australian Inst. of Nuclear Science and Engineering, Lucas Heights). At. Energy Aust.; 15: No. 2, 2-5(Apr 1972).

The AINSE neutron diffraction group is operating 4 diffractometers on 2 of the HIFAR beam hole facilities—3 are on the 2-Tan beam hole which is a horizontal hole tangential to the core and passing from one side of the reactor to the other, and a powder diffractometer is on the 4H1 beam hole which passes through the biological shield and graphite reflector. Aspects of computer control of the diffractometers are described. Work carried out at present and anticipated development are discussed. A powder diffractometer and a polarized neutron diffractometer are at present being installed at the 4H5 beam hole facility, the latter having a tilting counter and being computer controlled. (MRM)

40992 CHARACTERISTICS OF AN ULTRAMICROMANOMETER UTILIZING A PHOTOMULTIPLIER. Lebon, Pierre; Boutry, G. A. (Conservatoire National des Arts et Metiers, Paris). Compt. Rend., Ser. B; 274: No. 8, 524-7(21 Feb 1972). (In French).

A micromanometer utilizing a photomultiplier to measure the luminous flux emitted by a very low pressure Penning discharge, is described. The anode current of the photomultiplier is a linear function of the pressure in the very low pressure region. The sensitivity is 800 A $\cdot$ torr^{-1} for air. The measurable pressure limit of $5 \cdot 10^{-12}$ torr may be reduced to 10^{-14} torr using a technique involving the counting of the photoelectrons. (France)

40993 PATIENT'S COUCH FOR RADIOLOGICAL RADIATION. Zaalberg, W. (to N. V. Philips' Gloeilampenfabrieken). Canadian Patent 895,750. 21 Mar 1972. Priority date 18 Jul 1968, Netherlands.

A patient's couch for radiological radiation was adapted to obviate as far as possible the restriction of the space angle in which the source of upward radiation can be arranged. (Canada)

40994 INTENSIFICATION SCREEN FOR RADIOGRAPHIC FILM. Bayol, R. M. A. (to Eastman Kodak Co.). Canadian Patent 892,296. 1 Feb 1972. Priority date 22 Feb 1968, France.

A new intensification screen was developed for radiographic films to increase the effective x and gamma ray sensitivity of the film without causing emulsion fogging. The radiographic film consists of a support, a light-sensitive silver halide emulsion layer on one side of the support, and an intensification screen layer above the emulsion layer. The intensification screen is prepared by dispersing fine particles of a low melting point alloy in an aqueous film-forming binder which is cooled and coated on a support. An alloy of lead, bismuth, tin and cadmium, melting below 95°C, is suggested. (Canada)

40995 ENCYCLOPEDIA OF INSTRUMENTATION AND CONTROL. Considine, Douglas M. (ed.). New York; McGraw-Hill Book Company (1971). 810p. $29.50.

Although the nearly 700 topical entries are arranged alphabetically, the information content was delineated first in terms of major functions and systems. There are five principal information categories: (1) measurands—with ten subclassifications, including the chemical composition, electrical, force, geometric, physical property, quantity, radiation, rate, thermal, and time variables; (2) measurement systems—with subclassifications concerned with the basic building blocks used (mechanical, electrical, electronic, optical and so on) and with performance characteristics, errors, and compensation; (3) instrument data processing—with the subelements of acquisition, computing, programming, communication, and display; (4) control systems—with the important subcategories of control actions, configurations, and modes; control media (electric, electronic, fluidic, hydraulic, pneumatic, and so on); final controlling elements, such as valves and motor drives; and switching elements; and finally (5) applications—with in-depth attention given to uses in aerospace, astronomy, design and drafting, geophysics, machine control, medicine and biochemistry, meteorology and hydrology, navigation, oceanography, process control, and testing and inspecting. Cross references between entries are used extensively. A classified index and a comprehensive alphabetical index are included. (W.H.K.)

40996 MASS SPECTROMETER-COMPUTER SYSTEM FOR ANALYSIS OF H_2, HD, D_2 MIXTURES. Stahl, Daniel; Houriet, Raymond; Gaeumann, Tino (Institut de Chimie-Physique, Lausanne, Switzerland). Chimia (Aarau); 26: No. 5, 243-6(15 May 1972). (In French).

A method is described that allows measurement of small quantities (<1 μmol) of H_2, HD, D_2 mixtures. A residual gas analyzer is coupled with a small computer programmed as signal averager. The different sources of errors are discussed. (4 figures) (auth)

40997 ELEMENTAL ANALYZING APPARATUS. Goff, Robert F.; Smith, David P. (to Minnesota Mining and Mfg. Co.). U. S. Patent 3,665,182. 23 May 1972. Filed 18 Aug 1969.

A compact instrument for solid surface analysis is described. It comprises a compact ion generator, a movable target support, an energy analyzer, and an ion detector mounted together on a flange adapted to form the end wall of a vacuum chamber. (4 figures) (auth)

40998 PHYSICAL METHODS OF CHEMISTRY. Weissberger, Arnold; Rossiter, Bryant W. (eds.). Techniques of Chemistry. Volume I. New York; John Wiley and Sons, Inc. (1972). 801p.

Chapters by different authors on the following subjects are included: interferometry, light scattering, light microscopy, electron microscopy, microwave spectroscopy, electron spin resonance, nuclear magnetic resonance, and x-ray microscopy. Each chapter attempts to provide a clear understanding of the basic theory and apparatus involved and an appreciation of the value, potential, and limitations of the respective techniques. Representative applications are included as illustrations, and an extensive list of references follows each chapter. (A.G.W.)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

40999 INVESTIGATION OF TRANS-URANIUM ELEMENTS. Manoharlal (Bhabha Atomic Research Centre, Bombay). Vaigyanik; 3: No. 3, 5-9; 12; 45(Jul 1971). (In Hindi).

Transuranium elements falling in the range of atomic numbers from 93 to 105 are described briefly. The discovery, production, properties, and uses of each element are also mentioned. The uses of ^{235}U and ^{238}U are reported. A table contains the elements, the names of discoverers, and the year of discovery. (INIS)

Isotope Separation (Industrial)

Refer also to abstract 42477.

41000 DIFFUSION AND FLOW OF BINARY GASEOUS MIXTURES IN POROUS MEDIA. Breton, J. P. (CEN de Saclay, Gif-sur-Yvette, France). Rev. Gen. Therm.; 11: No. 123, 203-16(Mar 1972). (In French).

A unified description of gaseous flow and diffusion at constant temperature in porous media is presented. The experimental results are interpreted (on the molecular scale and on the continuous scale) from the characteristics of the gas, the gas wall interaction, and the structure of the porous medium. The general expression for the flux as a function of the gradients is derived from the principles of irreversible thermodynamics. Explicit expressions for these fluxes are obtained by integrating the Boltzmann equation with the introduction of the appropriate boundary conditions in the solution. In this way the mixture separation (and the isotopic separation) is explained; the separation may be due to mass differences, size differences or the reflection law. The differences between the generally accepted laws and the experimental results are interpreted in terms of uniform or nonuniform pressure interdiffusion. (France)

41001 STATUS OF URANIUM ENRICHMENT IN EUROPE. Mohrhauer, H. Atomwirt., Atomtech.; 17: No. 6, 300-5(Jun 1972). (In German).

Technical practicality and economical feasibility are examined based on research, development, and prototype installations. Three enrichment procedures are considered for large scale application in European uranium enrichment facilities with cooperation of German industry. The decisive factor for selection of the final procedure will be the lowest cost per kg separation work. Economic comparisons revealed that the centrifuge yields the best conditions for inexpensive uranium enrichment in Europe. Such facilities could go into operation approximately in 1980. (tr-auth)

41002 DETERMINATION OF THE INTERMOLECULAR POTENTIAL FROM THE TEMPERATURE DEPENDENCE OF THE SHAPE FACTORS IN A THERMAL DIFFUSION COLUMN. Youssef, Adel; Hanna, Magdi Morcos; Saad, Shoukry Mohamed (Atomic Energy Establishment, Cairo). Z. Phys. Chem. (Leipzig); 249: No. 3-4, 225-35(1972).

Two procedures are introduced for using the separation data obtained in thermal diffusion columns for providing information about the intermolecular forces. The methods are based on two empirical relations obtained for the column shape factors h and k_c in case of molecules represented by point centers of repulsion. These expressions are chosen to be simple analytical functions of the ratio of the operating temperatures and the ratio of the column radii satisfying the boundary conditions of the column. The force index can be obtained with the help of these relations by studying the temperature dependence of h and k_c, in spite of the existence of parasitic remixing. The procedures are examined by studying the separation of neon isotopes in a glass-hot-wire thermal diffusion column. The results obtained are found to be in good agreement with those inferred from transport properties data. (auth)

41003 CONSTRUCTION AND PUTTING INTO OPERATION OF A TECHNICAL SEPARATION NOZZLE STAGE FOR THE ENRICHMENT OF ^{235}U. Becker, E. W.; Bier, W.; Frey, G.; (and others) (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). pp 670-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A technical separation nozzle stage for the enrichment of uranium 235 has been built in the Nuclear Research Center Karlsruhe in cooperation with industry and was put into operation in July 1970 without separating tubes, using a UF_6/He mixture. The testing of single separation tubes in a special test-loop of the stage and the expected separation effectiveness with complete packing of separating units, as well as the future development of the process are outlined. (INIS)

41004 URANIUM ISOTOPE ENRICHMENT WITH CASCADE ARRANGEMENTS. Coester, E.; Langbein, G.; Wehlen, J. (Uran-Isotopentrennungs GmbH, Juelich, Ger.). pp 674-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A general formula is given with the help of which the cascade dimensions can be calculated from the refluxes at the product and waste end, from the enrichment and depletion stage numbers, and from the data on the separation units. The dependence of the effectiveness and of the degree of surface utilization on the reflux at the product end has been calculated for symmetrical and asymmetrical separation units by variation of different parameters. (INIS)

41005 OPERATION OPTIMIZATION OF ENRICHMENT PLANTS AND OF THE ERECTION OF A HIGHER SEPARATION CAPACITY. Messer, K. P.; Wehlen, J. (Uran-Isotopentrennungs GmbH, Juelich, Ger.). pp 678-81 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The expected development of an optimum tails assay and the adaption of a higher separation capacity arrangement to the requirements in Europe are set forth. (INIS)

41006 SEPARATION OF BORON ISOTOPES. Blum, J. M. (Societe Isobore, Sevres, France); Marteau, S. Energ. Nucl. (Paris); 14: No. 1, 33-7(1972). (In French).

The various ways of separating B isotopes are reviewed. The utilization of an ion exchange process is discussed in detail. The plant of the Isobore company is described. The various uses of the different B isotopes are also described in detail. (France)

41007 VISCOSITY OF LIQUID NEON ISOTOPES. Bratby, P. A. W.; Harris, E. A. (Univ. of Sheffield, Eng.). Phys. Lett.; 40A: No. 1, 25-6(19 Jun 1972).

Measurements of the shear viscosity of liquid ^{20}Ne and ^{22}Ne along the boiling line between 25.4 and 32.8°K support the classical $\eta \propto M^{1/2}$ relation at the higher temperatures. Departures from classical behavior observed as lower temperatures could arise from quantum effects. (auth)

Isotopic Power Sources

Refer also to abstracts 40627, 40761, 40762, and 42205.

41008 (ARCO-3057-9) RADIOISOTOPE POWERED CARDIAC PACEMAKER PROGRAM, PHASE II. Quarterly Progress Report, February 1, 1972–April 30, 1972. (ARCO Nuclear Co., Leechburg, Pa.). 1972. Contract AT(11-1)-3057. 70p. Dep. NTIS.

The results of development work performed from Feb. 1 to Apr. 30, 1972 in the Radioisotope-Powered Cardiac Pacemaker are reported. Twenty-seven pacemakers were implanted in dogs. Five failed resulting in discontinuation of production and dog implantation until extensive testing can verify the cause of failure. Experimental model life test data are presented. Procedures for the disassembly of failed units are described. Paint shaker tests were devised to simulate the dog-movement environment. Data obtained on thermopile deflection versus acceleration loads are presented. The ability of an implanted pacemaker to maintain its integrity when exposed to severe accident conditions such as bullet impact, intense fire, crash impact, or rupture due to crushing and the likelihood of such accidents to a pacemaker-wearer are discussed. (L.C.L.)

41009 (HIT-176) DERIVATION OF A GROUND TEST PROGRAM TO DEFINE THE REENTRY DESTRUCTION POTENTIAL OF VARIOUS RADIOISOTOPE FUEL FORMS. (Hittman Associates, Inc., Baltimore, Md.). 30 Jun 1965. Contract W-7405-eng-26. 150p. Dep. NTIS.
Declassified 27 Oct 1971.

An experimental program for providing needed information on the ablation of radioisotope fuels during reentry was devised and is described. The recommended program was developed on the basis of a detailed review of the reentry process, an analysis of required testing conditions, and an evaluation of available test facilities. It quickly became evident in the course of the analysis that no single test facility can satisfy all the requirements of a test program of this scope. The recommended ground test program consists of two phases. In Phase I, small cylindrical capsules loaded with simulated fuel materials are exposed to reentry conditions in dynamic and static tests, and the release of molten fuel from the capsules and the resulting breakup into droplets observed. In Phase II, small particles of simulated fuel materials are exposed to reentry conditions in dynamic and static tests and the droplet ablation process is observed. Droplet diameters will range from approximately 10 to 100 microns. Prior to initiation of full-scale programs, preliminary efforts must be carried out in both Phases I and II to ascertain the effectiveness of proposed simulation and monitoring techniques. The materials to be tested, procedures for dynamic and static testing, objectives of the testing program, and test program cost are discussed. (L.C.L.)

41010 (MLM-1896(OP)) MULTIHUNDRED WATT HEAT SOURCE TECHNOLOGY. II. Johnson, E. W. (Mound Lab., Miamisburg, Ohio). 1972. Contract AT-33-1-GEN-53. 6p. (CONF-720607-7). Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

Work on advanced heat source converter design, designated as the Multi-Hundred Watt (MHW) program, is reported. Fuel candidates considered are plutonia-molybdenum cermet (PMC) and pure plutonium oxide (PPO). Full-size fuel spheres (both PMC and PPO) were subjected to a variety of test conditions. Such tests include short and long term operational temperature "soaks" of the fuel, and other environmental condition tests. Descriptions and results are presented. Other aspects of heat source development reported include welding development, fabrication of test units, fabrication of fueled units, and other related assembly development. (J.R.D.)

41011 TRANSVENOUS STIMULATION OF THE PHRENIC NERVES. Furman, Seymour; Koerner, Spencer K.; Escher, Doris J. W.; (and others) (Montefiore Hospital and Medical Center, Bronx, N. Y. Albert Einstein Coll. of Medicine, Bronx, N. Y.). J. Thorac. Cardiovasc. Surg.; 62: No. 5, 743-51(Nov 1971).

Transvenous stimulation of the right phrenic nerve was accomplished in dogs by means of a distensible loop catheter inserted via a larger straight-lumen catheter. The loop catheter assumed a fully curved position in the low superior vena cava where it pressed lightly against the vena caval wall. The pulse generator was uniquely versatile, capable of altering the modulation, timing, amplitude, wave form, duration, polarity, and respiratory rate of the impulse trains. After the animals had been rendered apneic with morphine, their tidal volume and minute ventilation could be regulated with ease to almost any level. The figures for tidal and minute volumes represent the average maximum volumes that could be obtained. The least energy output and the smoothest inspiration and expiration were obtained by increasing the modulation of the stimuli from 30 to 100 pulses per second at a pulse duration of 0.5 msec with a respiratory rate of 16 per minute. Parallel with the development of electrodes and physiologic investigation, development of a nuclear-powered phrenic nerve stimulator was undertaken in an attempt to develop an energy source capable of prolonged stimulation. The generator uses ^{238}Pu (half-life 89 years) as the nuclear source and employs a double-redundant thermopile to convert heat to electrical energy. The unit is a disk, 2.74 inches in diameter and 1.12 inches thick, and weighs 198 g. (It is heavier and larger than a conventional cardiac pacemaker by about one third.) The electrodes for this implanted model are standard Medtronic cuff electrodes designed for carotid sinus stimulation. (auth)

41012 HIGH VERSATILE RADIOISOTOPE THERMOELECTRIC GENERATOR. Streb, Alan J.; Stivers, George S.; Kelly, Howard R. (to Teledyne, Inc.). U. S. Patent 3,668,015. 6 Jun 1972. Filed 15 May 1967.

An improved thermoelectric generator assembly including a radioisotopic heat source capsule, thermal insulation in the form of an open-ended cup surrounding the capsule and directing the heat axially toward the open end, shielding means including an open-ended corrosion-resistant cylindrical casing for receiving the cup-shaped insulation and the heat source capsule in nested fashion is described. Thermoelectric converter means are positioned within the open end of the cup-shaped insulation, thermally coupled to the heat source capsule, and a first highly heat-conductive cover overlies the thermoelectric converter means with its periphery contacting a portion of the open-ended casing. A second corrosion-resistant cover overlying the first cover is sealed to the cylindrical casing and forms a highly corrosion-resistant assembly. (Official Gazette)

Radiation Sources

Refer also to abstracts 40760, 40772, 40786, 40791, 40926, 40936, and 41378.

41013 (BRH/DMRE-72-4) AFTERLOADING IN RADIOTHERAPY. Proceedings of a Conference held in New York City, May 6-8, 1971. Simon, Norman (ed.) (Bureau of Radiological Health, Rockville, Md.). Dec 1971. 504p. (CONF-710536). GPO.

This conference was held to present and discuss the status of afterloading in the interstitial and intracavitary treatment of cancer in the United States and other countries, with special consideration given to radiation protection and control factors. Afterloading is a procedure for placing hollow devices and containers into tumors. The radioactive material is subsequently placed into these containers. The first session of the conference was devoted to discussions of the hazards of radium and radium substitutes in the treatment of cancer, the development and current status of afterloading techniques in various nations, and the use of computers in radiotherapy. The second session discussed dosimetry, treatment of cancer of the uterus, and interstitial techniques. In the third session, there was an open discussion on standardization of afterloading sources. (L.C.L.)

41014 NEUTRON GENERATOR. Kozlov, Stanislav Federovich; Mints, Anatoly Zakharovich. British Patent 1,276,079. 1 Jun 1972. Priority date 31 Mar 1970, Russia.

The generator comprises a housing containing an ion source, a target which emits neutrons and charged particles during ion bombardment, and a charged-particle detector. The target and the detector are located in series one after another directly in the path of the beam from the ion source. A diamond crystal plate detector with contacts formed at opposite sides adapted for application of an electric field to the plate is used. One of the contacts forms a blocking contact in relation to the charge carriers and faces the ion source, the opposite contact forms an injecting contact in relation to the charge carriers. (J.R.D.)

41015 RADIOACTIVE SOURCE PROJECTOR FOR PLESIOCURIETHERAPY. Chassagne, Daniel; Delouche, Gilles; Fradin, Jean; Rocoplan, Jean-Antoine (to Commissariat a l'Energie Atomique). British Patent 1,274,633. 17 May 1972. Priority date 28 Feb 1969, France.

A radioactive source projector is described for use in plesiocurietherapy. The applicator is similar to conventionally designed non-radioactive sources. The source is used for the treatment of cancerous lesions at the surface of the human body or in cavities. (J.R.D.)

41016 CURIE MEASUREMENT OF ^{60}Co-SOURCE BY ^{9}Be(γ,n) REACTION. II. Fujishiro, Masatoshi; Furuta, Junichiro. Annu. Rep. Radiat. Center Osaka Prefect.; 12: 84-5(1971).

The activity (Ci) of a ^{60}Co-source was measured by applying the photonuclear reaction ^{9}Be(γ,n). The result thus measured was $\frac{1}{2}$ to approximately $\frac{1}{3}$ of the value due to the usual exposure rate measurement by a Radacon probe, when Wolfson's branching ratio $\delta = 1.2 \times 10^{-3}\%$ and Dixon's one $\delta = 0.7 \times 10^{-3}\%$, and Jakobson's cross section $\sigma_{\gamma,n} = 0.27$ mb were used for the calculation of the curies. From the present and previous results either the branching ratio or the cross section is considered to be overestimated. (auth)

41017 SPECIAL STATE STANDARD FOR THE UNIT OF RADIONUCLIDE ACTIVITY IN GASES. Isaev, B. M.; Bregadze, Yu. I.; Zhdanova, N. F.; (and others) Meas. Tech. (USSR) (Engl. Transl.); 14: No. 11, 1629-32(Nov 1971).

Translated from Izmer. Tekh.; 14: No. 11, 8-10(Nov 1971).

Investigations of the standard of the unit of radionuclide activity in gases show that the standard ensures the reproduction of the activity unit with an error of 1 to 2% in the activity range 10 to 20×10^4 dps/m^3. With the help of working standards using gaseous radioactive sources, the transfer of the activity unit to test measuring instruments is ensured; from these to working measuring instruments through a planned verification scheme follows. (auth)

41018 CHARACTERISTICS OF ^{170}Tm FOR INDUSTRIAL RADIOGRAPHY. Furuta, Junichiro; Hiraoka, Eiichi; Tsujii, Yukio. Annu. Rep. Radiat. Center Osaka Prefect.; 12: 71-5(1971).

The characteristics of ^{170}Tm for use as a radiation source in industrial radiography were investigated. The relation between the photographic density and the lead foil screen thickness were studied, and the exposure curves for steel are given. The fault sensitivity curves for wire penetrameters are derived. The ^{170}Tm source can be used for thin steel to obtain radiographs of better quality than any other radioisotope source presently available. The use of lead foil screen and the effects of background high-energy x-rays produced by the source are discussed. (auth)

41019 MEASUREMENT OF THE ACTIVITY OF THE ^{54}Mn RADIONUCLIDE IN A SOURCE. Aristov, E. A.; Zhdanova, N. F. Meas. Tech. (USSR) (Engl. Transl.); 14: No. 11, 1729-31(Nov 1971).

Translated from Izmer. Tekh.; 14: No. 11, 67-8(Nov 1971).

Results of measurement of the activity ^{54}Mn sources, carried out by the coincidence and 4π-counting method, show that the average value for the product $P_kW_k = 0.201 \pm 1.6\%$. If it is assumed that $P_k = 0.9 \pm 1\%$, then $W_k = 0.223 \pm 2.6\%$. This value is in excellent agreement with the theoretical value of $W_k = 0.228$ calculated by other workers, but differs from the results obtained where $W_k = 0.262$ to 0.280. Using the measured results of the activity of the ^{54}Mn nuclide by the 4π(e,x)-γ-coincidence method, it can be shown that W_k cannot assume values from 0.262 to 0.280. Thus, in the case when the source was closed from both ends by a film with a thickness of ~0.00005 g/cm^2, was found that $\epsilon_x = P_kW_k(1 - f_A) + P_k(1 - W_k)\,\epsilon_0 = 0.189$, eq. 8, from the ratios of the count rate in the coincidence channel and the γ-channel, where ϵ_0 is the efficiency of the Δπ-counter to Auger electrons taking into account the absorption in the film and in the source. From Eq. (8) $P_kW_k(1 - f_A) \leq 0.189$. The relative absorption in the film in this case is ~7%, i.e., $>(1 - f_A) > 0.93$ and, consequently, $P_kW_k \leq 0.205$. If $P_k = 0.9 \pm 1\%$, when $W_k \leq 0.228$. (auth)

Industrial Uses

Refer also to abstracts 40680 and 41109.

41020 (INR-1383) RADIOTRACER METHOD FOR THE CHEMICAL ELEMENTS BALANCING IN TECHNOLOGICAL PROCESSES. Michalik, Jerzy Stanislaw (Institute of Nuclear Research, Warsaw (Poland)). 1972. 118p. (In Polish). Dep. NTIS (U. S. Sales Only).

The development of new industrial technologies and the optimization and modernization of present production processes very often require examination of the movement of a given chemical element in the process. In practice, the elements having the role of based or admixed components are often introduced to the process simultaneously with the several raw materials and are distributed among the final products of process. In these conditions examination of element transfer between the reactants, estimation of the elements movement parameters, and also evaluation of results of this process e.g., the element balance, can be done by the radiotracer method presented. The basic principle of this method is data interpretation which permits determination of the chemical elements balance parameters. The manner of data interpretation described permits organization of experiments under industrial conditions, so that obtaining the needed results is assured. This is valid for practically all continuously and periodically operating processes. The methods for interpreting radiometric measurement data and also of the most valid technological data are based on the physicochemical models of the technological processes. In the case of continuously and stationary operating processes, the principles of the response function analysis which are usually applicated in process dynamics are also applied. The method presented has been used in the metallurgical industry for balancing of sulfur and phosphorus in the bloom production process and for sulfur and chromium balancing in the open-hearth process. (auth)

41021 NEUTRON SPECTRUM MAP OF THE JANUS IRRADIATION FACILITY USING PROTON-RECOIL PROPORTIONAL COUNTERS. Bennett, Edgar F.; Yule, Thomas J. (Argonne National Lab., Ill.). Radiat. Res.; 50: No. 2, 219-33(May 1972).

Neutron spectra were measured with proton-recoil proportional counters at various locations in a high-flux irradiation cell used for biological investigations. The energy range of the measurements is from 1 keV to 2 MeV. Rate-of-pulse-rise information was used to distinguish proton recoils from gamma-ray induced fast electron events. The proton-recoil distributions were corrected for various inherent distortions such as those resulting from the deviation of the electric field in the counter from infinite coaxial-cylinder values. Systematic variations are noted in the shape and magnitude of the neutron spectra as a function of cell position. The influence on the spectra of having specimens present in the room is shown. The neutron spectrum near the center of the cell is compared with a calculated spectrum based on a one-dimensional model of the cell. The discrete-ordinate transport equations were solved using a multienergy-group cross-section set. (auth)

41022 FINNISH APPLICATIONS OF RADIOISOTOPES. Kuusi, J. (Reactor Lab., Otaniemi, Finland). Isotop. Radiat. Technol.; 9: No. 3, 359-60(Spring 1972).

A review of development programs for radioisotopes in Finland is presented. Projects included in the programs are devoted to development of radioisotopic methods of analysis for industrial quality and process control, research on tracer techniques, and special studies on the use of radiation and radioisotopes. (J.R.D.)

41023 RECENT ADVANCES IN APPLICATIONS OF ISOTOPES AND RADIATION IN THE UNITED STATES. Fowler, E. E. (Atomic Energy Commission, Washington, D. C.). Isotop. Radiat. Technol.; 9: No. 3, 253-63(Spring 1972).

An overview is presented of recent developments in radioisotope and radiation technology in the United States with emphasis on areas that can best benefit developing nations. Growth in the quantity and variety of radioisotopes produced in the United States is discussed in relation to use trends. New radioisotopes now being developed for large-scale use in the United States are identified and their potential applications are described, with emphasis on medical uses. The production of medical grade ^{238}Pu oxide is described in a status report of the U. S. Atomic Energy Commission (USAEC) Artificial Heart Program. Field experience with newly available radioisotope instruments and tracer techniques, which have special utility in developing nations, is critically examined. These include radioisotope x-ray-fluorescence analyzers for industrial uses, two new types of radioisotope snow gages, a sediment-tracing system for coastal waterways studies, an oil-slick-identification technique, new gages for highway construction, and new gaging and on-line analysis techniques for control of mineral beneficiation. Special attention is given to work under way on the use of radioisotopes and radiation in air- and water-pollution measurement and control. The current usage of both accelerators and radioisotopes as radiation sources in processing industrial products in the United States is discussed. The USAEC programs on Radiation Processing and Food Irradiation are described. The properties of several potentially useful new composite materials produced by radiation processing are given. A discussion of the policy considerations that guide the USAEC Isotopes Development Program is included. (auth)

41024 USE OF RADIOACTIVE NUCLIDES FOR THE INVESTIGATION OF FLOW IN A PLATE COLUMN. Zablotny, W. (Institut fuer Kernforschung, Warsaw). Isotopenpraxis; 8: No. 2, 37-41(Feb 1972). (In German).

Using a ^{24}Na-tagged sodium carbonate solution, the flow behavior of the liquid phase in a plate column was investigated. The time intervals during which the solution remained at different locations along the column were measured. These measurements permit the calculation of mixing coefficients and of the degree of liquid phase mixing. The results obtained were used to eliminate problems which occur during the production of soda. (tr-auth)

LIFE SCIENCES

41025 (WASH-1211) BIOLOGICAL, MEDICAL, AND ENVIRONMENTAL RESEARCH PROGRAM. (Division of Biology and Medicine (AEC), Washington, D. C.). 1972. 29p.

An analysis of the purposes and implementation of the AEC biological, medical, and environmental research program is presented: effects of radiation on living organisms; molecular and cellular radiobiology; radiation genetics; exposure of man to external and internal radiation; combating detrimental effects of radiation; chemical toxicity; land and freshwater environmental sciences; marine sciences; atmospheric sciences; nuclear energy civil effects; radiological and health physics and instrumentation; nuclear medical research; biological and agricultural research; and food irradiation. A statement providing general information to investigators for preparing and submitting research proposals is appended. (H.L.W.)

41026 ABSTRACTS OF THE FOURTEENTH ANNUAL MEETING OF THE JAPAN RADIATION RESEARCH SOCIETY, MISHIMA, JAPAN, NOVEMBER 6–7, 1971. J. Radiat. Res.; 13: No. 1, 1-58 (Mar 1972). (CONF-711139–(Absts.)).

One hundred and sixty-one abstracts are presented describing research activities in the following areas: environmental radioactivity; radiation biochemistry; radiation chemistry; radioactivity in plant and animal systems; radiosensitivity of cells and animals; late effects and aging; radiosensitivity of animals and plants; recovery; nucleic acids; recovery in multicellular systems; DNA strand scissions and chromosome aberrations; radiation genetics; cell death; radiation immunology; fundamental radiotherapy and and carcinogenesis; cellular radiobiology; chemical protection; and radiation biochemistry and physiology. An author index is included. (E.R.B.)

41027 LIFE SCIENCES AND SPACE RESEARCH. VIII. Proceedings of the Open Meeting of Working Group V at the Twelfth Plenary Meeting of COSPAR, Prague, May 11–24, 1969 and the Symposium on Biological Rhythms, Prague, May 13, 1969 and the Symposium on Nutrition of Man in Space, Prague, May 14, 1969. Vishniac, W.; Favorite, F. G. (eds.). Amsterdam; North-Holland Publishing Company (1970). 327p. (CONF-690516).

The proceedings of the life sciences sessions of the Twelfth Plenary Meeting of the Committee on Space Research (COSPAR), the symposium on Biological Rhythms, and the Symposium on Nutrition of Man in Space are presented. The COSPAR proceedings include the results of biological experiments in space, research on exobiology, and studies on sterilization methods for space flight. Separate abstracts were prepared for three of the papers in the COSPAR proceedings. (E.R.B.)

For abstracts of individual papers see: 41079, 41192, and 41226.

Radiation Effects on Biochemicals (External Source)

Refer also to abstract 41063.

41028 (AEC-tr-7307, pp 18-23) EFFECT OF CELL ANOXIA ON THE RADIATION INDUCED RATE OF DNA DEGRADATION. Ivannik, B. P.; Nesterenko, V. S.; Priskarev, A. V. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). Translated from Radiobiologiya; 11: No. 6, 825-9(1971).

Rats and mice were irradiated with ^{60}Co gamma-rays in a dose of 1000 rad with a dose intensity of 3 krad/min. It is shown that the cell anoxia created both due to the mechanical cessation of external respiration and due to a decrease in normal atmospheric pressure in the pressure chamber reliably reduces the appearance of individual breaks during the postradiation degradation of DNA. The detected slowing in the rate of postradiation DNA degradation is observed only under cell anoxia conditions. After cessation of cell anoxia an acceleration of the process of postradiation DNA degradation is observed. (tr-auth)

41029 (AEC-tr-7307, pp 24-9) CHANGE IN THE CONTENT AND RATE OF INCORPORATION OF THE PHOSPHORUS IN NUCLEIC ACIDS IN THE LIVER OF ANIMALS IN THE DYNAMICS OF ACUTE RADIATION SICKNESS UNDER THE INFLUENCE OF BONE MARROW HOMOTRANSPLANTATION. Shamray, A. E.; Koval, A. I. (Kiev Scientific Research Inst. of Hematology and Blood Transfusion). Translated from Radiobiologiya; 11: No. 6, 830-4(1971).

A study was made of the influence of bone marrow homotransplantation on the content and rate of incorporation of phosphorus in nucleic acids in the liver of animals in the dynamics of acute radiation sickness. Irradiation of the animals by x rays (in a dose of 800 to 850 R) results in a marked decrease in the content and an impairment in the rate of incorporation of phosphorus in liver DNA and RNA. Bone marrow homotransplantation favors a relatively rapid relative normalization of both the content of nucleic acids and the relative specific activity of the phosphorus within them. (tr-auth)

41030 (AEC-tr-7307, pp 44-50) ACTIVITY AND CHANGE IN THE STRUCTURE OF PHOSPHOFRUCTOKINASE IN THE MUSCLES OF RABBITS IRRADIATED BY X RADIATION. Chumachenko, Yu. V.; Dvornikova, P. D.; Lototskaya, L. S.; Matsuy, S. P.; Volodina, T. T.; Gulyi, M. F. (Biochemistry Inst., Kiev). Translated from Radiobiologiya; 11: No. 6, 846-50(1971).

The irradiation (800 R) of rabbits is accompanied by changes in activity, the UV spectrum, and peptide charts of the enzyme phosphofructokinase (PFK). The increase in PFK activity in the muscle homogenates of irradiated animals disappears during crystallization and is 90 to 170 units/mg of protein. The authors give the amino acid composition of peptide No 1, absent in the tryptic hydrolysate of PFK in irradiated animals. It is concluded that there is a change in the primary structure and properties of PFK isolated from the muscles of the irradiated rabbits. (tr-auth)

41031 (AEC-tr-7307, pp 51-7) STUDY OF THE ACTIVITY OF MULTIPLE FORMS OF LIVER ESTERASES AND BLOOD SERUM IN RATS DURING ACUTE RADIATION DAMAGE. Bochkova, D. N.; Surinov, B. P.; Aleksandrova, S. V.; Kashkin, K. P. (Scientific Research Inst. of Medical Radiobiology, Obninsk, USSR). Translated from Radiobiologiya; 11: No. 6, 851-6(1971).

A study was made of the change in activity of multiple forms of liver esterases and blood serum during acute radiation damage. The activity of most isoforms of liver esterases changes in the dynamics of radiation sickness, in contrast to the insignificant changes in total esterase activity. The changes in activity of the fractions of esterases in tris-saccharose and desoxycholate liver extracts revealed an impairment in the ratio of activity of the esterases in hyaloplasm and subcellular granules. After irradiation, the blood serum exhibits a maximum decrease in the activity of carboxyl esterase. The content of aryl esterase is reduced only at late observation times. During the 7 days of acute radiation sickness the rat blood contains isoforms of esterases absent in intact animals and coinciding in electrophoretic mobility with tissue esterases. (tr-auth)

41032 (AEC-tr-7307, pp 109-12) POSSIBLE MECHANISM OF THE POSTRADIATION THERAPEUTIC EFFECT OF POLYSACCHARIDES. Kuzin, A. M.; Kadzhaya, A. S.; Merkulov, A. S. (Inst. of Biological Physics, Pushchino, USSR). Translated from Radiobiologiya; 11: No. 6, 897-9(1971).

It is shown that complex polysaccharides (lipopolysaccharides) from grape skins, reducing by 40 to 50% the mortality of animals when injected after irradiation, have the capacity to bind water-soluble radiotoxins. It is postulated that the mechanism of the action of lipopolysaccharides, like other high-polymer substances, is caused by the sorption of radiotoxins (cell division inhibitors) forming in the irradiated body. (tr-auth)

41033 (BRH/DBE-72-1) LOW AND VERY LOW DOSE INFLUENCES OF IONIZING RADIATIONS ON CELLS AND ORGANISMS, INCLUDING MAN: A BIBLIOGRAPHY. Sonnenblick, Benjamin P. (Rutgers–The State Univ., New Brunswick, N. J.). Feb 1972. Contract PH 86-67-133. 325p. NTIS.

The bibliography lists 3418 citations to literature pertaining to the influence of low and very low doses of ionizing radiations on cells, organelles, intracellular macromolecules, organisms, and populations. The citations are divided into eleven categories as follows: human studies; mammalian studies; other vertebrate studies; invertebrate studies; plant studies; microorganism studies; macromolecule studies; dose studies; space studies; natural background studies; and general studies. Citations in the eleven categories that refer to very low dose studies are listed separately (E.R.B.)

41034 (NP-19272) EIGHTH REPORT, 1969–1970. (Norsk Hydro's Inst. for Cancer Research, Oslo). 1971. 76p. Dep. NTIS (U. S. Sales Only).

Research achievements during 1969 and 1970 are reported for the following laboratories: pathology; tissue culture; genetics; biochemistry; and biophysics. Preliminary results are reported in the following radiation studies: the mechanism by which 2,2,6,6-tetramethyl-4-oxo-piperidine-N-oxyl (TAN) modifies radioinduced damage to DNA; the mechanism of transfer of unpaired spins in the solid state; the mechanism of the indirect action of radiation in frozen solution; and the x-ray modification of the regulatory function of allosteric enzymes. (E.R.B.)

41035 (RLO-2225-T-15-10) PHOTOBIOLOGY AND PHOTOCHEMISTRY OF RIBONUCLEIC ACIDS. Comprehensive Three-Year Report. Gordon, Milton P. (Washington Univ., Seattle). [1970]. Contract AT(45-1)-2225. 18p. Dep. NTIS.

Experiments were conducted on the nature of ultraviolet-induced chemical lesions repaired by photoreactivation of RNA from tobacco mosaic virus and potato virus X and the role of pyrimidine cyclobutane dimers in photoreactivation. In vitro photoreactivation of RNA was demonstrated using extracts from seedlings of Nicotiana tabacum and studies on uv-irradiated RNA from Escherichia coli indicated that in vitro treatment repaired the same sort of inactivating lesions as are repaired in vivo. Studies on environmental effects on the ability of assay plants to photoreactivate viral nucleic acids included effects of continuous illumination and effects of illumination from a 40W black light bulb. It is suggested that results are consistent with the presence of a photoreactivating enzyme system in green plants. Experiments on the action of sunlight on RNA showed unequivocal dimerization of the pyrimidine residues to form pyrimidine cyclobutane dimers. (H.L.W.)

41036 RADIATION ALTERS THE ABILITY OF MAMMALIAN CELL DNA TO COMPETE IN DNA:DNA HYBRIDIZATION SYSTEM. Dalrymple, Glenn V.; Sanders, J. L.; Moss, A. J. Jr.; (and others) (Univ. of Arkansas, Little Rock. Veterans Administration Hospital, Little Rock, Ark.). Biochem. Biophys. Res. Commun.; 47: No. 4, 938-43(26 May 1972).

Murine lymphoma cells were maintained both as ascites tumors and in cell culture. One mouse with ascites tumor was x-irradiated and DNA from irradiated and control mice was isolated and labeled with tritiated thymidine. A graph is presented to show the change in ability of DNA to compete after irradiation. The reciprocal of the percent of labeled DNA is shown as a function of competitor DNA concentration. Results show that 5000 rads destroy the ability of DNA to compete in the DNA: DNA hybridization system. (H.L.W.)

41037 NATURE OF ULTRAVIOLET LIGHT-INDUCED STRAND BREAKAGE IN DNA CONTAINING BROMOURACIL. Dodson, M. L. Jr.; Hewitt, R.; Mandel, M. (Univ. of Texas, Houston). Photochem. Photobiol.; 16: No. 1, 15-25(Jul 1972).

Single-strand breaks were produced in the phosphodiester backbone of ultraviolet-light-irradiated 5-bromodeoxyuridine-containing DNA (BU-DNA) after treatment with alkali. No radiation dependent breakage was observed in thymine-containing DNA (thy-DNA). The relative yields of breaks terminated by 5′-hydroxyl and 5′-phosphate groups was determined by measuring the rate of phosphorylation achieved with polynucleotide kinase in BU-DNA single strands before and after treatment with alkaline phosphatase. The ratio of 5′-phosphate to 5′-hydroxyl groups ranged from 2.3 to 2.9 in different experiments. When cysteamine was present during irradiation no new end groups were produced. In order to identify the nucleoside(s) at the 5′-termini, phosphate groups were removed with alkaline phosphatase and the 5′-hydroxyl groups were phosphorylated with polynucleotide kinase. Electrophoresis of enzymatic digests showed a single ^{32}P-labeled component migrating more rapidly than any of the four usual 5′-mononucleotides. Upon column chromatography this component resolved into a major peak coincident with deoxyuridine-5′-monophosphate 5′-dUMP and a lesser unidentified constituent. No bromodeoxyuridine-5′-monophosphate (5′-dBUM^{32}P) was observed among these nucleotides. (UK)

41038 RADIOSENSITIVITY OF ATP:L-METHIONINE S-ADENOSYLTRANSFERASE. Hancock, R. L.; Giblak, R. E. (Univ. of Calgary, Alberta). Experientia; 28: No. 4, 409(15 Apr 1972).

Methods for preparation and assay of ATP : L-methionine S-adenosyltransferase are described. It was shown that the enzyme was resistant to x radiation up to a 10 kR dose and it appeared to be less radiosensitive than yeast cytidylate kinase prepared in a similar fashion. It was concluded that mouse liver S-adenosyltransferase is not a radiosensitive enzyme and thus could be categorized as very resistant in comparison with some other enzymes. (H.L.W.)

41039 DECREASE IN PLATELET SURFACE CHARGE DURING PHAGOCYTOSIS OF POLYSTYRENE LATEX PARTICLES OR THORIUM DIOXIDE. Groettum, K. A.; Joergensen, L.; Jeremic, M. (Univ. of Oslo). Scand. J. Haematol.; 9: No. 1, 83-96(Feb 1972).

Incubation of platelet-rich citrated plasma with polystyrene particles induced surface contact between blood platelets and particles, uptake of particles, and changes in platelet morphology. EDTA inhibited both the surface contact between platelets and particles and the uptake of particles. Polystyrene particles and thorium dioxide reduced the electrophoretic mobility of human platelets in vitro. Injected into rabbits, both types of particles induced reduction in platelet electrophoretic mobility, platelet aggregation and thrombocytopenia. The reduction in platelet surface charge is suggested to render the platelets more susceptible to aggregation and phagocytosis in the reticuloendothelial system. (auth)

41040 CONFORMATIONAL CHANGES INDUCED IN TOBACCO MOSAIC VIRUS NUCLEIC ACID BY ULTRAVIOLET RADIATION. Wang, Tso-ming; McLaren, A. D. (Univ. of California, Berkeley). Contract AT(11-1)-34. Biophysik; 8: No. 3, 237-44(1972).

In order to study any conformational changes associated with ultraviolet irradiation of TMV-RNA, methods of circular dichroism and absorbance-temperature profile were applied. RNA irradiated in water at 254 nm showed a distinct change in CD spectrum, but there was only a slight change accompanying irradiation in phosphate buffer. A small change in absorbance-temperature profile at 258 nm is associated with irradiation of RNA in water; RNA irradiated in phosphate buffer and Mg^{++} solutions showed essentially no changes. It is concluded that conformational changes accompanying irradiation of RNA in water are greater than those taking place in phosphate or magnesium solutions, and the enhanced change in water is related to the larger quantum yield for inactivation found in water than in buffer solutions. (auth)

41041 TRANSCRIPTION AND RADIATION DAMAGE IN T7 PHAGES. Ronto, Gyorgyi. Magy. Tud. Akad. Biol. Tud. Oszt. Kozlem.; 14: No. 3, 251-5(20 Jan 1972). (In Hungarian).

Radiobiophysical findings were presented to elucidate the localization of the radiation damage of T7 DNA and the more precise delimitation of the radiation kinetic model of RONTO, Gy., and TARJAN, I. The radiation source employed in the experiments was a light with a wavelength of 254 nm; the dose-effect diagrams for the spot-forming inactivation of the T7 phages were determined. The pyrimidines were the most vulnerable; generally, the radiation damage was localized on the concrete structural element of the DNA molecule. A proposed scheme was presented for the biological manifestations of radiation damage. Twenty-four references, including 3 German, 3 Hungarian, and 18 Western. (JPRS)

41042 IN VITRO DETERMINATION OF SOLUBILITY OF ^{133}Xe AND ^{85}Kr IN HUMAN LIVER TISSUE WITH VARYING TRIGLYCERIDE CONTENT. Kitani, K. (Rigshospitalet, Copenhagen); Winkler, K. Scand. J. Clin. Lab. Invest.; 29: No. 2, 173-6(Apr 1972).

The solubility of ^{133}Xe and ^{85}Kr in liver tissue with varying lipid content measured enzymatically as triglyceride was determined in vitro. The influence of phospholipids was found to be unimportant. The error of the method is constant (SD = 0.7) at lipid concentrations below 5%, and increases to about 5 at a hepatic lipid content of 25%. These results can be used for the estimation of hepatic lipid content and perfusion in vivo by the tissue clearances of ^{133}Xe and ^{85}Kr. (auth)

41043 RADIATION-BIOLOGICAL ASPECTS OF THE CONTROL OF RNA POLYMERASE. Damjanovics, Sandor; Somogyi, Bela (Univ., Debrecen, Hungary. Univ. of Medical Sciences, Debrecen, Hungary). Magy. Tud. Akad. Biol. Tud. Oszt. Kozlem.; 14: No. 3, 263-73(20 Jan 1972). (In Hungarian).

It was stated that the radiation-sensitivity of the individual enzymes or of their catalytic activities can be separated. Studies were made to establish whether the control of the activity of the polymerase of Escherichia coli by the ionic strength of the incubation mixture is damaged to the same extent as the catalytic activity upon irradiation of the polymerase. The mechanisms involved in these processes were discussed. Both the template and the enzyme were held co-responsible for the ionic control of the transcription. (JPRS)

41044 CONCEPTS IN RADIATION CELL BIOLOGY. Whitson, Gary L. (ed.). Cell Biology: A Series of Monographs. New York; Academic Press Inc. (1972). 292p. $16.50.

Separate abstracts were prepared for seven of the eight chapters in the book. The other chapter discusses the photodynamic action of laser light on cells. (E.R.B.)

For abstracts of individual chapters see: 41045, 41076, 41077, 41091, 41190, 41224, and 41225.

41045 ULTRAVIOLET IRRADIATION OF DNA. Rahn, Ronald O. (Oak Ridge National Lab., Tenn.). pp 1-56 of Concepts in Radiation Cell Biology. /Whitson, Gary L. (ed.). New York; Academic Press Inc. (1972).

In the ten years since thymine dimers were first isolated from irradiated DNA, the field of photobiology has become increasingly more sophisticated. With time, more photoproducts have been discovered and more discriminating methods of measuring these photoproducts have emerged. Most important, the study of repair systems that operate specifically on certain photoproducts has assumed a central role in molecular photobiology. Armed with a knowledge of the relative rates of both photoproduct formation and repair, the investigator is in a good position to quantitatively interpret the complex events that follow the irradiation of a cell. It is important to realize that much of the knowledge of photoproduct formation in DNA is based on information obtained from irradiated DNA that has undergone hydrolytic degradation. Hence, acid-labile photoproducts of possible biological significance may be present before hydrolysis but are never isolated because of alterations during the isolation procedure. A fruitful area of future investigation, therefore, would be one connected with the analysis of photoproducts in intact DNA. It is also important to remember that the doses needed to obtain easily measurable quantities of photoproducts are usually much larger than the doses used in the normal biological experiment. We have also seen that both the nature and the rate of formation of a wide variety of photoproducts in DNA are sensitive to the state of the DNA during irradiation. Because some conditions favor certain photoproducts over others, the photochemical properties of DNA reflect changes in the environment and possibly the secondary structure of the DNA. In this sense, photoproducts can be looked upon as probes of the structure of DNA. Therefore, the study of the photochemistry of DNA is of interest not only to photobiologists but also to those concerned primarily with the structure of DNA. Finally, the study of the enzymatic repair of photoproducts other than pyrimidine dimers should prove useful in elucidating the mechanism by which repair enzymes recognize specific lesions in the DNA. Undoubtedly, the future will see the isolation of a variety of enzymes intimately involved in some phase of the repair process. The task will be to characterize these enzymes on the basis of their substrate requirements. In particular, it will be desirable to know whether an enzyme such as a uv-specific endonuclease functions on one type of photoproduct but not on another. It is hoped that such studies will help us understand more about recognition phenomena and enzymatic catalysis in biopolymers. (auth)

41046 EFFECT OF X-IRRADIATION ON THE BASAL AND SUBSTRATE-INDUCED LEVEL OF TRYPTOPHAN OXYGENASE AND THE BIOSYNTHESIS OF NUCLEIC ACIDS IN THE LIVER OF CHICKEN EMBRYOS. Petrovic, J.; Kanazir, D. T. (Inst. for Biological Research, Belgrade). Strahlentherapie; 143: No. 4, 454-62(Apr 1972).

The effect of x-irradiation on the basal and substrate-induced level of tryptophan oxygenase (tryptophan pyrrolase, E.C. 1.13.1.12) in the liver of chicken embryos has been studied. No changes in basal or substrate-induced activity of tryptophan oxygenase 5 hours after irradiation have been observed. However, 24 hours after irradiation an increase in both basal and substrate-induced level of this enzyme was found. This increase in enzymatic activity is accompanied with an increase in the nucleic acids biosynthesis. These effects exist even in the longer periods of time after irradiation (4 days). That means that x-irradiation in the dose range used (400 R) could have a permanent stimulatory effect on both processes. (auth)

41047 BIOCHEMICAL ACTION OF SEVERAL RADIOSENSITIZING SUBSTANCES. Streffer, C.; Schweiger, K. (Univ., Freiburg i. B.). Strahlentherapie; 143: No. 3, 244-54(Mar 1972). (In German).

A discussion is presented of two classes of substances whose sensitizing effect was examined in radiobiology as well as in radiotherapy: halogenated pyrimidines and inhibitors of protein-biosynthesis. Of the halogenated pyrimidines, 5-iodo-uracil, 5-bromo-uracil, 5-fluoro-uracil and the corresponding desoxyribosides were examined in particular. On base of the molecular structure in comparison to uracil and thymine, the 5-bromo-uracil and the 5-iodo-uracil can be built into the DNA of mammalian cells instead of thymine, whereas the 5-fluoro-uracil is incorporated into the RNA instead of uracil. After an injection of 5-bromodesoxyuridine (5-BUDR) in mice, 50 hours following a partial hepatectomy, the incorporation rate into the DNA of the liver is constant during 60 minutes; subsequently it decreases. This process mainly is referable to the fact that the injected 5-BUDR is decomposed rapidly. Hereby, 5-bromo-uracil, 5-bromo-uridine and 5-hydroxyuridine develop first. The prompt decomposition of the 5-BUDR was also observed in man. The incorporation rate of the 5-BUDR can be increased with 5-fluoro-uracil, as 5-fluorouracil inhibits the synthesis of thymidine in vivo. Therefore the incorporation of thymine into the DNA is decreased in favor of the 5-bromo-uracil. Moreover, 5-fluoro-uracil can be employed for the synchronisation of the cellular cycle including tumor cells. In the cellular range, the inhibitors of the protein-biosynthesis, actinomycin D and puromycin, proved to be radiosensitizers. Experimental investigations on animals showed that both antibiotics have a strong radiosensitizing effect on the induction of enzymes by cortisol in the liver parenchyma. The ionizing radiation as well as the inhibitors of the protein-biosynthesis were applied in doses which gave no effect when applied separately. The combination of both treatments led to a marked decrease of the enzymic induction. Finally, some practical directions are given and the conditions discussed which are prerequisite for a radiosensitization requiring an experimental examination. (auth)

41048 RADIATION PROTECTION OF HEPARIN IN THE SOLID STATE. Moore, J. S.; Phillips, G. O.; Rhys, D. (Univ. of Salford, Eng.). Radiat. Res.; 50: No. 3, 479-90(Jun 1972).

Heparin and its complexes with the detergents cetyl pyridinium chloride, cetyl dimethylbenzylammonium bromide, and cetyl trimethylammonium bromide have been γ-irradiated in the solid state. Uncomplexed heparin is extensively depolymerized, with accompanying formation of acid (G = 10), reducing groups (G = 2) and inorganic sulfate (G = 14). No such depolymerization occurs and no products can be detected when heparin–cetyl pyridinium chloride complex is irradiated, and the original heparin may be recovered unchanged. ESR and reflectance spectroscopy provide additional evidence that heparin can be protected from damage by ionizing radiations when complexed with a suitable counterion. Energy transfer from the carbohydrate to the complexed molecule is indicated. (auth)

Radiation Effects on Cells (External Source)

Refer also to abstracts 41033 and 41184.

41049 (AEC-tr-7307, pp 76-81) INTENSIFYING THE BIOLOGICAL EFFECTS OF IONIZING RADIATIONS. COMMUNICATION 4. RADIOSENSITIZING EFFECT OF SMALL IRRADIATION DOSES. Kalendo, G. S.; Yarmonenko, S. P.; Vinskaya, N. P. (Inst. of Experimental and Clinical Oncology, Moscow). Translated from Radiobiologiya; 11: No. 6, 871-4(1971).

It is shown that the irradiation of HeLa cells in doses of 5 to 20 R activates the synthesis of DNA, causes a decrease in the total level of endogenous thiols, and is accompanied by an increase in radiosensitivity (10 R). With preliminary irradiation in a dose of 10 R the detected radiosensitizing effect is brief (2 to 5 minutes after irradiation); it appears only in an intact monolayer of culture and is absent in the irradiation of cells in suspension or in the lag phase of growth. (tr-auth)

41050 (AEC-tr-7307, pp 170-3) EFFECT OF GAMMA RAYS ON THE ACCUMULATION OF POTATO X VIRUS IN A TOBACCO TISSUE CULTURE. Zhuk, I. P.; Didenko, L. F.; Anokhin, V. M. (Inst. of Microbiology and Virology, Kiev). Translated from Radiobiologiya; 11: No. 6, 937-40(1971).

Callus tissue of tobacco of the Samsun variety, contaminated by potato X virus (PXV) 15 days after transplantation, was irradiated by gamma-rays in a dose of 300 to 2900 rad. The irradiation favored a large accumulation of the virus in the callus tissue in comparison with the unirradiated control and this increased progressively with an increase in the dose and the time between irradiation and the determination. (tr-auth)

41051 (COO-78-276) ANNUAL REPORT FOR PERIOD ENDING APRIL 30, 1972. Friedell, Hymer L. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Radiology). 10 May 1972. Contract W-31-109-eng-78. 100p. Dep. NTIS.

- CELL MEMBRANES—radiation effects on osmotic adaptation of mammalian
- CELLS, CULTURED—radiosensitivity of U12C fibroblast, effects of transfer trauma on x
  - —radiation effects on survival of U12C fibroblast, following fractionated exposure, dose and time dependence of x
- CHROMOSOMES—translocations of human, fluorescence methods for evaluation of
- EGGS—radiosensitivity of sea urchin, nuclear-cytoplasmic relations in
  - —radioinduced mitotic delay in sea urchin, dark recovery from uv
  - —radioinduced mitotic delay in sea urchin, prefertilization stimulation of recovery from γ
- ELECTRONS—reactions of quasi-free, in dielectric liquids as a function of dose rate
- NUCLEIC ACID, DEOXYRIBO-,—replication in Physarum polycephalum, mechanism and control of
  - —radiation effects on synthesis and repair of, in Physarum polycephalum
- PROTEINS—radiation effects on synthesis of, in HeLa cells, γ

PROTOZOA—Tetrahymena pyriformis, radioinduced reduction in polysome content of, γ
RADIOISOTOPE SCANNERS—performance of spiral
RADIOISOTOPES—uptake by human organs as a function of time, instrumentation for clinical imaging and measurement of
TRANSFERASES—radiation effects on synthesis of thymidine kinase in Physarum polycephalum, (E.R.B.)

41052 EVALUATION OF RADIATION DAMAGE IN MAMMALIAN CELLS DUE TO THE HYDROXYL RADICAL. Roots, Ruth. Rochester, N. Y.; Univ. of Rochester (1970). 181p. University Microfilms Order No. 72-14,707.

Thesis.

The main purpose of this investigation was to ascertain which of the three water radicals (OH·, H· or e^-_{aq}) is primarily responsible for the indirect action in radiation damage of mammalian cells; to correlate cell sensitivity with DNA single and double strand breaks; in addition, the hydroxyl radical diffusion distance was calculated from data on cell killings as well as from studies of DNA single strand breaks and double strand cuts; further, the degree of protection offered by alcohols and sulfhydryl (R-SH) compounds against x-ray irradiation was compared; and finally, x-ray induced DNA breakage was studied with freeze-dried cells in order to compare the indirect action of DNA damage for cells in the normal aqueous state versus that of the dry state. Several alcohols, R-SH compounds and one R-S-S-R substance were selected as radiation protectors, based on their reaction rate constants with the hydroxyl radical, the hydrogen atom and the hydrated electron. Each of these radical scavengers was dissolved in phosphate buffered saline and added to pellets of sedimented L 5178Y cells nine minutes before x-ray irradiation. The criteria used to evaluate radiation damage caused by the radiolytic products of water were radiation induced cell killing and DNA breakage. The former was evaluated by colony survival and the latter was studied by the use of the alkaline and neutral sucrose gradient centrifugation techniques. In the case of DNA breakage, the data show a linear relationship between the hydroxyl radical reaction rate constants and the concentration of free radical scavenger needed for half maximum protection. This relationship cannot be demonstrated for the hydrogen atom or the hydrated electron (e^-_{aq}). If one assumes the potential agents for indirect radiation damage are OH·, and H· and e^-_{aq}, it can be concluded that the hydroxyl radical is largely responsible for the indirect action in x-ray induced DNA single strand breaks. In terms of radiation induced cell killing, results from dose response curves for cells incubated with various concentrations of an hydroxyl radical scavenger during irradiation show that $^6/_{10}$ of the total radiation injury is caused by the hydroxyl radical. The percent indirect effect was evaluated to be about 65% from data on cell killing and to vary between 69% and 85% as evaluated from DNA breakage depending on total x-ray dose and on whether assays were for double or single strand breakage. When data were evaluated for correlation between x-ray induced cell killing and DNA breakage, a high radiosensitivity was shown to correspond to a high degree of either single or double strand breaks. However, this correlation could not be demonstrated to be a linear relationship at all dose ranges used in our study of DNA breakage. The hydroxyl radical diffusion distance at 37°C was calculated from cell killing data to be about 41 Å; when the diffusion length was calculated from data on DNA breakage, the value varied between about 20 and 30 Å depending on the total x-ray dose. The R-SH compounds studied showed a maximum possible protection beyond that attainable by the alcohols when DNA single strand breaks were evaluated at 10 kilorads. The results of the freeze-dry experiments did not show a decrease in DNA single strand breaks as compared to that in the wet state. The Freeze-dry process did not cause breaks per se. A possible explanation for the results is offered in the discussion. (Diss. Abstr. Int., B)

41053 RADIOSENSITIVITIES OF MURINE LYMPHOMA L 5178 Y CELLS IN A MULTI-CELLULAR COLONY SYSTEM. Shinohara, K.; Okada, S. (Tokyo Univ.). J. Radiat. Res.; 13: No. 2, 109-16(Jun 1972).

Mouse lymphocytic leukemia L 5178 Y in colonies showed decreased radiosensitivity over that in free cell suspension. The decreased radiosensitivity is not sufficiently explained with the increased fraction of stationary phase cells, nor with cell-to-cell interaction, nor with protection by agar in the plating medium. The main cause is likely to be the depletion of oxygen in the multicellular system. The radiosensitivity of stationary phase cells in free cell suspension was slightly, but significantly lower than that of log phase cells. (auth)

41054 FUNCTIONAL CAPACITY OF X-IRRADIATED MACROPHAGES. Schmidtke, Jon R.; Dixon, Frank J. (Scripps Clinic and Research Foundation, La Jolla, Calif.). J. Immunol.; 108: No. 6, 1624-30(Jun 1972).

Graded doses of x-irradiation (up to 10,000 R) had no effect on the uptake and little effect on the catabolism of keyhole limpet hemocyanin (KLH) or human γ-globulin (HGG) in vitro by macrophages from non-immunized CBA or A mice. After uptake and catabolism, however, greater amounts of KLH and HGG remained associated with the plasma membrane of x-irradiated (10,000 R) macrophages compared with control cells. Because of their greater surface binding of antigens, x-irradiated macrophages after transfer to normal mice were more effective in inducing immune responses to antigens to which they were exposed in vitro than were normal macrophages. This increased immunogenicity of KLH bound to x-irradiated macrophages was abrogated by treating the cells with trypsin before transfer. In addition, transfer of normal macrophages carrying KLH or HGG to sublethally irradiated mice did not reconstitute their ability to form antibody to these proteins. (auth)

41055 DNA SINGLE-STRAND BREAKS PRODUCED IN MAMMALIAN CELLS BY IONIZING RADIATION AFTER TREATMENT WITH 2,4-DINITROPHENOL. Palcic, B.; Skarsgard, L. D. (McMaster Univ., Hamilton, Ont.). Int. J. Radiat. Biol.; 21: No. 6, 535-44(Jun 1972).

Cultured mammalian cells (mouse fibroblasts, Chinese hamster cells and human skin fibroblasts) were treated with 2,4-dinitrophenol (DNP) and the production of DNA single-strand breaks by γ-irradiation was studied over a dose range 0 to 25 krads, using the sedimentation method of alkaline sucrose gradients. The number of breaks observed was unaffected by the presence of either 1×10^{-4} M DNP or 5×10^{-4} M DNP. It is suggested that these breaks were not a consequence of nucleolytic enzymes acting after irradiation, but rather that they were produced by direct physicochemical action. (auth) (UK)

41056 ENHANCEMENT OF ^{32}P INCORPORATION INTO PHOSPHOLIPIDS IN CULTURED CELLS BY SENDAI VIRUS OF PARAINFLUENZA TYPE 1. Shibuta, Hiroshi; Yamaura, Koichi; Hirano, Koichi; Matumoto, Minoru (Tokyo Univ.). Jap. J. Microbiol.; 15: No. 2, 185-91(Mar 1971).

Sendai virus infection enhanced ^{32}P incorporation into phospholipids in the chick embryo, monkey kidney, and bovine kidney cells, as previously observed in chorioallantoic membranes of chick embryos. These findings indicate that phospholipid synthesis is enhanced upon Sendai virus infection. Ultraviolet irradiation abolished the ability of the virus to induce the enhanced synthesis of phospholipids, a fact suggesting that the phenomenon depends upon infectivity of the virus. Gamma irradiation of host cells little affected the enhanced ^{32}P labeling of cellular phospholipids, suggesting that the function of host cell DNA may not be directly involved in the phenomenon. (auth) (Japan)

41057 EFFECTS OF BROMODEOXYURIDINE (BUdR) ON RADIATION-INDUCED DNA BREAKAGE AND SUBSEQUENT REJOINING IN CULTURED MAMMALIAN CELLS. Sawada, S.; Okada, S. (Univ. of Rochester, N. Y.). Int. J. Radiat. Biol.; 21: No. 6, 599-602(Jun 1972).

The effects of BUdR-labelling on the rejoining of DNA single-strand breaks and double-strand cuts in cultured mouse leukemia cells were studied. Labelling resulted in an increase in radiation induced DNA breakage of single and double strands, slowed down the rejoining processes for single strand breaks and inhibited the rejoining of double-strand cuts. The number of radiation induced single and double strand cuts was plotted over an x ray dose range of 0 to 55 Krads. The rejoining of single-strand breaks after doses of 5 and 10 Krads was observed during an incubation time of up to 80 min. Rejoining of double-strand cuts was observed after a dose of 10 Krads for up to 240 min. (UK)

41058 BIOCHEMICAL INVESTIGATIONS IN RABBIT RETICULOCYTES FOLLOWING THE APPLICATION OF IONIZING RADIATION. **Mainzer, K.; Ladner, H.-A.; Hahn, K. (Univ., Mainz). Strahlentherapie; 143: No. 4, 463-7(Apr 1972). (In German).**

After irradiation of rabbit reticulocytes in vitro a loss of cellular potassium and a contemporaneous increase of potassium and myokinase activity in the suspension medium as well as an increase in cell volume was observed, followed by a decrease of the incorporation of leucine. The changes mentioned first can be explained as being signs of hemolysis. An increase of enzymes of the glycolysis and the pentose phosphate cycle was observed only if enzymatic activity was related to the cell count; probably it is stimulated by enzymes originating from hemolyzed cells which were included in the measurement. (auth)

41059 TRANSIENT CHANGE IN THE RADIOSENSITIVITY OF MAMMALIAN CELLS RESULTING FROM A CHANGE IN THE PRE-IRRADIATION CULTURE CONDITIONS. Cullen, Beulah (Hammersmith Hospital, London). Int. J. Radiat. Biol.; 21: No. 6, 583-94(Jun 1972).

Mouse Ehrlich ascites cells were grown in vitro as a monolayer culture (BC cells) and in vivo as ascites tumors developed from intraperitoneal inoculation of cells from an in vitro culture (MC cells). Both BC and MC cells were irradiated and assayed in vitro. The D_0 values for MC cells were always lower than those for BC cells, irrespective of the phase of growth of the tumor. The extrapolation number for MC cells was sometimes higher but never lower than that for BC cells. The fraction of MC cells surviving a fixed dose of irradiation depended on the interval between plating the cells in vitro and irradiation. Survival reached a minimum, usually when this interval was between 4 and 6 hr, and increased again to the constant value measured for BC cells within one or two division cycles. The effect could not be attributed to partial synchronization of the population in the mitotic cycle. (auth) (UK)

41060 SEDIMENTATION PROPERTIES OF MAMMALIAN-CELL DNA: EVIDENCE THAT NON-SPECIFIC MOLECULAR AGGREGATION DOSES NOT OCCUR DURING CELL LYSIS. Belli, J. A.; Cooper, S.; Brown, J. A. (Harvard Medical School, Boston). Int. J. Radiat. Biol.; 21: No. 6, 603-6(Jun 1972).

Chinese hamster fibroblasts were irradiated with 2000, 4000 and 8000 R of 50 kV x rays in the presence of air or 100% nitrogen at room temperatures (25° to 27°C). Results of alkaline sucrose gradient studies indicated that the sedimentation behavior of DNA was dependent on gas conditions at the time of exposure. Experiments with lysing cell populations labelled with ^{3}H-thymidine (zero R) or ^{14}C-thymidine (4000 R) at the top of the gradient showed that it was possible to distinguish between DNA from unirradiated and irradiated cells in the same gradient. It is suggested that the results indicate that non-specific molecular aggregation is minor, if present at all, during cell lysis. (UK)

41061 HIGH RESISTANCE OF IMMUNOCOMPETENT SPLEEN CELLS TO REPEATED EXPOSURE TO γ RADIATION AND ITS ABOLITION BY SYNGENEIC LYMPHOCYTES. Petrov, R. V.; Cheredeev, A. N. (Inst. of Biophysics, Moscow). Cell. Immunol.; 3: No. 2, 326-32(Feb 1972).

Spleen cells from mice, subjected to γ-radiation at dose 500 R and taken 14 days later, possessed an increased radioresistance to their capacity to accumulate antibody-producing cells in culture. The addition of syngeneic lymphocytes to radioresistant spleen cells abolished the effect of radioresistance. It is suggested that high radioresistance of immunocompetent cell population may be a consequence of interference with normal cell-to-cell cooperation processes under conditions of decreased level of lymphocytes and of relatively elevated content of stem elements in postirradiated spleens. It seems likely that the change of lymphocyte : stem cell ratio on Day 14 after irradiation of mice decreases the occurrence of transmission of immunological information from lymphocyte to stem cell, and this situation may be estimated phenomenologically as high radioresistance of antibody-producing cells. (auth)

41062 UNEXPECTED RESISTANCE TO X-IRRADIATION IN A STRAIN OF HYBRID MAMMALIAN CELLS. Little, John B. (Harvard School of Public Health, Boston); Richardson, U. Ingrid; Tashjian, Armen H. Jr. Proc. Nat. Acad. Sci. U. S. A.; 69: No. 6, 1363-5(Jun 1972).

The radiosensitivities of a strain of mouse fibroblasts (Cl−1D), of rat pituitary cells (GH_12C_1), and of a hybrid between the two (α-RST) have been studied. Their mean chromosome numbers were 50, 70, and 111, respectively. The hybrid cells were much more resistant to radiation than either of the parent strains. The range of the D_0 (reciprocal of the slope, and therefore a measure of radiosensitivity) for the linear portion of the survival curves for each cell line was: Cl−1D, 134-142 R; GH_12C_1, 154-170 R; and α-RST, 248-274 R. There were no significant differences in the magnitude of the shoulder or extrapolation number of the survival curves, nor in the ability of the three cell strains to accumulate and repair sublethal radiation damage. It appears unlikely that the unusual resistance of the hybrid strain is simply related to the increase in chromosome number; more likely, it involves some interaction between the two genomes. The study of somatic cell hybrids may offer further insight into the factors controlling the radiosensitivity of mammalian cells. (auth)

Radiation Effects on Microorganisms (External Source)

Refer also to abstracts 41033 and 41051.

41063 (AECL-4154) BIOLOGY AND HEALTH PHYSICS DIVISION. Progress Report, October 1–December 31, 1971. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River (Ontario). Chalk River Nuclear Labs.). Mar 1972. 105p. (PR-B-92). Dep. NTIS (U. S. Sales Only). AECL $2.00.

Progress is reported in research activities in several fields: Biology: A project on genetic hazards is being carried on with an insect, Dahlbominus, showing that the mutation rate is directly proportional to radiation dose down to 15 R with no evidence of a threshold. A project on radiation-induced leukemia and other tumors in rats has been initiated. Extensive research on basic mechanisms of radiation damage and repair processes in the cell is being carried out. The degradation and repair of DNA which occurs in bacterial cells after irradiation are being studied with different mutants of E. coli, in an attempt to understand the mechanism of action of radio-sensitizing chemicals. The bacterium M. radiodurans is being studied since it is highly radiation resistant and capable of repairing extensive damage to its DNA. Methods are being developed for studying the molecular basis of repair processes in different strains of yeast cells which vary considerably in their capacity to survive radiation-induced damage. The genetic control of radiation sensitivity and the mechanisms by which stable mutants evolve after the initial mutagenic exposure are being studied in yeast. Studies on mechanisms of mutation are also being carried out with a bacteriophage, where the entire genetic material can be mapped accurately, in contrast to the much more complex material of higher organisms. A program on insect populations in the wild is being continued. Part of this program is concerned with a disease-carrying insect (Rhodnius) from South America and part with local populations of blackflies and mosquitoes. Population Research: The effects of exposing fish sperm to low doses of radiation (down to 25 rad) have been studied in relation to the production of both congenital malformations and changes in fertility. Methods for "linking" existing large files of vital and health records into individual and family histories have been extended, and use has been made of them to study diseases of man which it is thought might increase in frequency as a result of irradiation. A reanalysis of published data on the occurrence of childhood cancer following prenatal exposure to very low doses of radiation (down to 200 mrad) has been carried out. Environmental Research: Monitoring of the environment near to CRNL, including drainage from the Waste Management areas and the part of the Ottawa River affected by effluent from the Plant, continues to show that most of the detectable radioactivity originates from weapons fall-out. Activity in surface waters, piped effluent, radionuclides moving in the ground water and airborne activity are well within the strictest safety limits. The "working limits" set for the operations of CRNL are considerably below those established for public safety reasons. Water and mineral balance studies—the former in collaboration with the International Hydrologic Decade—are proceeding successfully in the Perch Lake Basin. Over 30 different elements are being assessed in the mineral balance study, using neutron activation analysis and spark source mass spectrometry. An investigation concerned with uptake of radionuclides from various types of soil into crop plants was designed to obtain information relevant to irrigation with contaminated water. The effect of heated effluent from the Gentilly Reactor on benthic organisms in the St. Lawrence River is being investigated. An experiment on the use of natural Sr as a marker for trout continues in cooperation with the Ontario Department of Lands and Forests. Work on growth of plankton and the influence of added nutrients has continued in lakes on CRNL property. Development of techniques for determination of dilution and mixing systems in large bodies of water has led to cooperative work and advisory services to outside bodies, particularly in the field of pesticide contamination of streams. The influence of pesticides on alkaline-earth metabolism of fish is also under examination in a laboratory-scale project. Use of nuclear techniques in work on pollution and allied problems is being developed in conjunction with the Canada Centre for Inland Waters. Among other projects a method is being developed for identifying spilled oil by neutron activation of "fingerprints"—i.e., traces of elements (e.g., La, As, and Sb) which appear in typical proportions in specific oils. Health Physics: Fast Neutron Dosimetry: Recent work on the techniques of etching and counting has now established the reliability and reproducibility of fast neutron dosimetry. Calculations have been made of the neutron leakage spectrum for a variety of different critical assemblies. The laboratory participated in the second IAEA Intercomparison Study on Nuclear Accident Dosimetry. Radiation Instrument Developments: The design of an automatic thermoluminescent dosimetry system has been completed and manufacture is proceeding with the intention of replacing the film dosimetry for personal radiation monitoring by TLD in 1972. Considerable effort has been given to the problem of tritium-in-air detection in the presence of noble gas contamination and, in one solution, the effect of the interfering activity has been reduced to 1%. Methods for tritium-in-water detection developed for health physics have been applied to heavy-water management, and D_2O leak detectors based upon the detection of tritium by scintillation techniques have been produced and are installed at the power reactors. Radiation Biophysics: Work is proceeding on the development of a scattering chamber in which the energy loss and scattering of low energy electrons will be measured. The development of a flying spot scanner for the estimation of amounts of DNA in thin sections is continuing with the optimization of circuit parameters to minimize sources of error and instability. Work has begun on high resolution electron microscopy of biological macromolecules. Direct imaging of single heavy metal atoms has been obtained and precedes their use as markers in tagged molecules. (auth)

41064 (CONF-720115–2) HYDROXYL RADICAL AND THE HYDRATED ELECTRON IN RADIATION EFFECTS IN CELLS. Powers, E. L. (Texas Univ., Austin. Lab. of Radiation Biology). [1971]. Contract AT(40-1)-3408. 22p. Dep. NTIS.

From Symposium on molecular basis of radiation biology; Jerusalem, Israel (3 Jan 1972).

A discussion is presented of the general role of water in radiation damage to bacterial spores and a model is described which includes the effects of oxygen, D_2O, and hydrogen sulfide. Evidence for hydroxyl radical participation on radiation effects on spores is discussed with regard to the N_2O series, biacetyl, NO_3^-, Ag^+, and other sensitizers. Models involving organic molecules are also discussed. (H.L.W.)

41065 (COO–3054-3(Pt.1)) EFFECTS OF ENVIRONMENTAL STRESS ON THE COMMUNITY STRUCTURE AND PRODUCTIVITY OF SALT MARSH EPIPHYTIC COMMUNITIES. Progress Report, September 1, 1971–August 31, 1972. Lee, John J. (City Coll., New York). Contract AT(11-1)-3254. 76p. Dep. NTIS.

The microbial and micrometazoan assemblages in salt marshes and shallow embayments in the greater New York City metropolitan region are being studied to gain insight into the functional relationships which regulate the community. By means of studies on labeled uptake and the growth of algae and bacteria on a differential series of media, and auxotrophic profile of the community over a summer growing season was obtained. Evidence suggests that dissolved organic nutrients are recycled and play a central role in the nutrition, community regulation, and succession within the unicellular algal compartment. The algae in the community vary widely in their sensitivity to ionizing radiation and thermal stress. At 40°C, some of the thermally more resistant species have an MLD > 135 min. Many of the same species are also more resistant to uv ($MLD > 4.5 \times 10^4$ ergs) and γ irradiation ($MLD \sim 1 \times 10^7$ ergs). This combination of resistance to stresses seems to be an adaptation to growth or repeated exposure at ebb tide in hot shallow tide pools or in interstitial waters. Light quality is also important in selectively regulating growth and succession among the algae. The trophic dynamics, mineral cycling, and niches of salt marsh sublittoral foraminifera were also studied. The ecological growth efficiency was estimated to be 21.5% in Rosalina leei, 12% in Allogromia laticollaris and only 5% in Spiroloculina hyalina. Other energetic measurements were also made. Tracer feeding and microcosm experiments provided some of the data used for testing a graphic representation of the Hutchinsonian niche. An equation based on competitive feeding experiments was used to reduce data to a single coefficient. (auth)

41066 (COO–3254-8) DIFFERENTIAL SENSITIVITY OF VARIOUS SPECIES OF SALT MARSH EPIPHYTIC ALGAE TO IONIZING RADIATION AND THERMAL STRESS. Saks, Norman M.; Lee, John J. (City Coll., New York. Dept. of Biology). 1972. Contract AT(11-1)-3254. 8p. (CONF-720708–1). Dep. NTIS.

From Symposium on the interaction of radioactive contaminants with the constituents of the marine environment; Seattle, WA. (10 Jul 1972).

Various species of diatoms and chlorophytic algae from a salt marsh community in Long Island were cultured and exposed to ultraviolet radiation at intervals of 30 to 420 min. Cultures were examined for viability of cells 14 days later. Other cultures were exposed to gamma radiation from a ^{60}Co source and viability was confirmed by subculture techniques. To test the effects of thermal stress cultures were immersed in a water bath at 40°C for 15 to 240 min. Results indicated a wide variation in sensitivity to radiation and thermal stress. Comparisons with marine algae are discussed and it is suggested that sensitivities to radiation and thermal stress are important niche vectors for littoral algae and play a role in community structure and succession. (H.L.W.)

41067 (ORO–3408-19) [PROGRESS REPORT ON PHYSICO-CHEMICAL STUDIES OF RADIATION EFFECTS IN CELLS]. Powers, E. L. (Texas Univ., Austin. Lab. of Radiation Biology). May 1972. Contract AT(40-1)-3408. 37p. Dep. NTIS.

Research in progress is directed at describing the series of events leading from the absorption of radiation energy to the expression of damage at the cellular level. Agents used for modifying response to radiation include water, gases, organic and inorganic compounds, metal ions, and heat. The bacterial spore is the primary test organism. Research is described on an in vivo assay for the detection of conformational changes in a sensitive spore component, DNA, which is sensitive to both heat and radiation. Effects of x radiation on survival of spores at different hydrogen ion concentrations were investigated. Sensitizing effects of calcium, cobalt, and silver ions were also studied. Effects of ultraviolet dose rate on spores were studied and it was found that very different uv sensitivities resulted when calcium, magnesium, and manganese were added to the culture medium. Other studies were conducted on effects of inert gases on radiosensitivity; effects of 300 kVp x rays on photosynthesis in Chlorella; radioinduced mutagenesis in Bacillus megaterium and B. subtilis spores; variations in ultraviolet sensitivity of spores during germination; and radiation chemistry of cellular inactivation. (H.L.W.)

41068 POST-IRRADIATION RECOVERY OF THE CELL. III. EFFECTS OF DARK REPAIR INHIBITORS AND CULTURE CONDITIONS ON SURVIVAL OF ESCHERICHIA COLI B AFTER UV AND X IRRADIATION. Vizdalova, M.; Yanovska, E.; Zhestyanikov, V. D. (Inst. of Biophysics, Brno. Inst. of Cytology, Leningrad). Tsitologiya; 14: No. 1, 113-20(Jan 1972). (In Russian).

A study was conducted on the influence of dark repair inhibitors (5-bromouracil, caffeine, and acriflavine) on the survival of Escherichia coli B following uv and x irradiation. There was a decrease in survival of irradiated bacteria treated with 5-bromouracil cultured at 44°; the sensitization factors for LD_{50} to LD_{90} doses were 2.4 to 1.6 and 3.0 to 2.0 respectively. Cultivation of irradiated bacteria with 0.3% caffeine resulted in decreased survival at 44°, but the survival level was not changed during cultivation at 19° or 37°. The addition of acriflavine caused a decrease in survival of irradiated bacteria under all conditions. The results may be explained by the inhibition of repair of the damaged cell division mechanism in the presence of dark repair inhibitors. (TSS)

41069 PHOTOSENSITIZATION OF COL Ib FACTOR BY 5-BROMODEOXYURIDINE. Buraczynska, Monika; Lorkiewicz, Zbigniew (Univ. M. Curie-Sklobdowska, Lublin, Poland). Mol. Gen. Genet.; 116: No. 1, 88-90(1972).

Col Ib factors which contain 5-bromodeoxyuridine–substituted DNA are highly sensitive to uv light. At the dose 3000 erg/mm^2 of uv light 95% of the surviving bacteria became noncolicinogenic. (auth)

41070 VEGETATIVE RECOMBINATION OF BACTERIOPHAGE Mu-1 IN ESCHERICHIA COLI. Wijffelman, Carel A.; Westmaas, Gerth C.; van de Putte, Pieter (Medical Biological Lab., Rijswijk, Netherlands). Mol. Gen. Genet.; 116: No. 1, 40-6(1972).

Twenty-two amber mutants of the thermoinducible mutator phage Mu-c4ts were isolated. These mutants fall into 11 complementation groups. The data obtained by crossing these amber mutants suggest that bacteriophage Mu-1 has a linear vegetative linkage map. In a recombination deficient host of the RecA type the recombination frequencies are extremely low, indicating that Mu-1, in contrast to many other E. coli phages, is dependent on the recombination system of its host. With λ as a helper phage, recombination between Mu phages in a RecA host is restored to about $\frac{1}{3}$ of the frequency in a Rec^+ host. Although Mu-1 is able to integrate efficiently into the chromosome of a RecA strain, it seems that its integration system does not contribute to vegetative recombination. The survival of uv-irradiated Mu-1 was measured on different radiation sensitive mutants of E. coli. The survival on a UvrB strain was very low as compared to the wild-type; the survival on a RecA strain was almost the same as on the wild-type. (auth)

41071 LIQUID-HOLDING EFFECTS IN U.V.-IRRADIATED PHAGE T3. Martignoni, S.; Harm, W. (Univ. of Texas, Dallas). Photochem. Photobiol.; 16: No. 1, 3-13(Jul 1972).

Holding complexes of uv-irradiated (254 nm) T3 phage in Escherichia coli B/r cells for several hours at 37°C in buffer, or broth with chloramphenicol, affected the phage survival in at least two ways: (1) by enhancing excision repair, resulting under certain conditions in liquid-holding recovery (LHR), (2) by destroying the phage (holding inactivation). LHR was most apparent in buffer containing 20 $\mu g\ ml^{-1}$ chloramphenicol (CAP). There was as much as a 10-fold increase in the fraction of complexes displaying host-cell reactivation (resulting from excision repair), but the percentage of uv lesions repaired within repair-proficient complexes was slightly decreased. LHR was not observed if T3 infected the repair-deficient strain B_{s-1}.

XU

Holding inactivation was readily observed with unirradiated phage complexes in broth containing CAP. The response of irradiated-phage complexes to liquid-holding conditions was more complex: holding inactivation was less effective for irradiated than for unirradiated phage DNA (i.e., the irradiated DNA is to some extent "protected"), and processes leading to LHR are superimposed. Thus, under certain holding conditions the viable titer of irradiated phage was several times higher than that of unirradiated phage. Holding inactivation did not require protein synthesis; it was rather enhanced at high CAP concentration and seemed to be favored by otherwise active cell metabolism. At high CAP concentrations (200 to 400 μg/ml, as compared to 20 μg/ml) irradiated-phage complexes showed neither LHR nor protection against holding inactivation. Likewise they failed to undergo some step by which the phage DNA becomes insensitive to repair inhibition by caffeine. (UK)

41072 INFLUENCE OF ENERGY METABOLISM ON THE REPAIR OF X-RAY DAMAGE IN LIVING CELLS. I. EFFECT OF RESPIRATORY INHIBITORS AND GLUCOSE ON THE LIQUID-HOLDING REACTIVATION IN YEAST. **Jain, V. K.; Pohlit, W. (Gesellschaft fuer Strahlen- und Umweltforschung, Frankfurt am Main). Biophysik; 8: No. 3, 254-63(1972).**

Liquid-holding reactivation in the yeast S. cerevisiae after x-irradiation was observed to be inhibited in the presence of 2,4 dinitrophenol, antimycin A, and KCN. However, this inhibition could be reversed by glucose. Radiation resistance and reactivation capacity of a respiratory-deficient mutant was also observed to increase by pre-irradiation incubation in glucose. It is concluded that post-irradiation reactivation is an ATP-dependent process. ATP required can be supplied by the fermentative or the respiratory pathways and the intracellular energy storage system(s) can profoundly influence the cellular radiation response. Significance of these results for the radiotherapy of tumors is discussed. (auth)

41073 LETHAL AND MUTAGENIC EFFECTS OF ELEVATED TEMPERATURE ON HAPLOID YEAST. I. VARIATIONS IN SENSITIVITY DURING THE CELL CYCLE. Schenberg-Frascino, Ana; Moustacchi, Ethel (Institut du Radium, Orsay, France). Mol. Gen. Genet.; 115: No. 3, 243-57(1972).

The lethal and cytoplasmic mutagenic effects of 52°C incubation during the cell cycle of a haploid strain of Saccharomyces cerevisiae were examined following exposure to γ, uv, or x radiation. Both effects varied periodically in a rather parallel pattern: the maximum thermosensitivity was seen at budding time, corresponding to the S period. The 52°C induction of a nuclear forward mutation was also examined: canavanine-resistant mutants were induced by this treatment. Exponentially growing cells were much more sensitive than resting cells to the different effects of heating which were studied. On the other hand, on comparing asynchronous cultures of 6 different radiosensitive mutants only one (xrs$_5$) showed a greater thermosensitivity than the corresponding wild type. (auth)

41074 SIGNIFICANCE OF DNA REPAIR AND DEGRADATION IN SPORAL RADIORESISTANCE. **Durban, Egon. Chicago; Illinois Inst. of Tech. (1971). 149p. University Microfilms Order No. 72-13,717.**

Thesis.

This investigation was undertaken to elucidate the basis for differences in radioresistance between spores belonging to the same bacterial species. Two strains of Clostridium botulinum were chosen exhibiting a 2.5-3 fold difference to gamma radiation as measured by colony survival. Spores of C. botulinum strain 33A had an average D_{10}(6 log), 10% survival dose over 6 log cycles, of 0.32 Mrad whereas spores of strain 51B had a D_{10}(6 log) of 0.12 Mrad. The shoulder in the gamma-ray survival curve of 33A spores could be reduced or completely eliminated by preirradiation with uv. Comparable uv dose (50% reduction) did not eliminate the small shoulder in strain 51B. There was about 7-fold higher positive interaction (synergism) between effect of uv and gamma-radiation in 33A spores. This was taken as evidence of repair processes in 33A which were either missing or much less effective in 51B. The intrinsic sensitivity of DNA to induction of single-strand breaks was tested by sedimentation analysis of alkaline sucrose gradients. A dose of 0.3 Mrad produced 0.29 breaks per average unirradiated DNA fragment in spores of 33A and 0.6 breaks in spores of 51B and using the unirradiated 33A average DNA fragment as reference, 2.3 breaks in 51B. When irradiated in the presence of EDTA almost twice as many single-strand breaks were introduced into the DNA of 33A spores (.54 per average DNA fragment) whereas no such sensitization occurred in 51B spores. The increase in DNA strand breaks in 33A spores was most likely due to inhibition of a "direct" repair process (repair during irradiation). Sedimentation patterns suggest that DNA from spores of 33A and 51B did not show any postirradiation repair. Instead, DNA of 33A spores exhibited some interesting type of degradation where the peak produced by dormant spores upon incubation, gradually decreased in size with concomitant appearance of a new peak of smaller size fragments. This phenomenon could be slowed down by reducing the temperature. The smaller sized fragments were TCA insoluble therefore, this type of degradation was different from the generally observed DNA breakdown leading to reduction in TCA insoluble material. This was confirmed by directly testing loss of radioactivity in the TCA insoluble fraction. No such loss occurred over 6 hr incubation time neither in 33A nor in 51B. DNA of 51B spores did not show this special type of degradation. (Diss. Abstr. Int., B)

41075 INFLUENCE OF RADIATION-INDUCED ELECTROLYTE DISTURBANCES ON METABOLISM. V. INVESTIGATIONS ON ETHANOL-CONSUMING YEAST. **Rink, H.; Bergeder, H.-D.; Proemse, B. (Univ., Bonn). Strahlentherapie; 143: No. 2, 225-31(Feb 1972). (In German).**

Irradiated and non-irradiated samples of ethanol-consuming yeast show a variable oxygen consumption, dependent on the extracellular potassium ionic concentration of the medium. The differences in the consumption of acetate and acetaldehyde are discussed. The activation of oxygen consumption by potassium ions, in presence of ethanol, is referred to the potassium-dependent aldehyde dehydrogenase reaction. This also limits the ethanol consumption. It results that radiation-induced electrolyte disturbances not only directly affect metabolic steps dependent on potassium and sodium ionic balance; beyond it, the electrolyte disturbances can affect preceding or succeeding reactions in the course of a metabolic chain. (auth)

41076 METHODS FOR PHOTOINACTIVATION OF VIRUSES. Hiatt, C. W. (Univ. of Texas, San Antonio). pp 57-89 of Concepts in Radiation Cell Biology. /Whitson, Gary L. (ed.). New York; Academic Press Inc. (1972).

Methods for the inactivation of viruses using uv radiation or photodynamic action are discussed. Both uv inactivation reactions and the various photooxidative processes known as photodynamic action (in which a photosensitizer is employed as a catalyst) differ from the effects induced by ionizing radiation in that their quantum efficiency is low (10^{-4} to 10^{-2}) and they are capable of selective action upon molecules of biological interest. Both characteristics result from the fact that the quantum energy of the radiations used (253.7 to 700 nm) is too low to cause ionization but has its effect through excitation of certain atoms, or molecules, to energy levels that permit them to engage in chemical reactions that are exceedingly improbable in the ground state, or normal energy level. Both methods are discussed in the light of their ability to inactivate animal and plant viruses. (E.R.B.)

41077 EFFECTS OF ULTRAVIOLET RADIATIONS ON BACTERIA. **Hamkalo, Barbara Ann (Oak Ridge National Lab., Tenn.). pp 91-121 of Concepts in Radiation Cell Biology. /Whitson, Gary L. (ed.). New York; Academic Press Inc. (1972).**

Experimental data gathered over the past 15 years that elucidate the mechanism of uv action in bacteria and substantiate the model developed by Kelner for this mechanism are reviewed. The following topics or areas of investigation are included in the discussion: uv-radioinduced changes in polynucleotides including pyrimidine dimers and other photoproducts; the excision and replacement of pyrimidine dimers in DNA; the measurement of radiosensitivity; the effects of pyrimidine dimers in DNA on the synthesis of DNA, RNA, and proteins; the physiology of irradiated cells; and the basis of mutation induction. (E.R.B.)

41078 GENETIC MAPPING OF PASTEURELLA PESTIS CHROMOSOME BY THE METHOD OF INDUCED MUTATIONS. **Suchkov, Yu. G.; Mishan'kin, B. N. (Antiplague Inst., Rostov-on-Don, USSR). Genetika; 8: No. 2, 140-4(Feb 1972). (In Russian).**

Different mutants were obtained by uv- and N-nitrosomethyl urea treatment of synchronously dividing cells of Pasteurella pestis ev. The differences between mutants were found to depend on the time of synchronous replication of DNA. First monomycin-resistant mutants appeared, then phenylalanine- and methionine-independent and finally streptomycin-resistant ones. It is suggested that the identified loci on P. pestis chromosome are located in the following manner: mon → phe → met → str. (auth)

41079 SURVIVAL OF MICROORGANISMS UNDER SIMULATED SPACE CONDITIONS. **Buecker, H.; Horneck, G. (Univ., Frankfurt am Main). Life Sci. Space Res.; 8: 33-8(1970).**

From twelfth plenary meeting of COSPAR; Prague, Czechoslovakia (11 May 1969). See CONF-690516.

Monocellular layers of stationary phase cells of Escherichia coli B/r were exposed to high vacuum of 10^{-6} Torr at different temperatures. After simultaneous irradiation with uv of 254 nm or x-rays, the survival was tested as colony forming ability. In vacuum the sensitivity to uv and x-rays was enhanced compared with the controls at atmospheric pressure. Of uv-inactivation in vacuum no photoreactivation was found. (auth)

41080 INDIRECT SUPPRESSION OF recB AND recC MUTATIONS Y EXONUCLEASE I DEFICIENCY. Kushner, Sidney R.; Nagaishi, Haruko; Clark, Alvin J. (Univ. of California, Berkeley). Proc. Nat. Acad. Sci. U. S. A.; 69: No. 6, 1366-70(Jun 1972).

Both the $recB^-$ and $recC^-$ strains of Escherichia coli K12 are recombination deficient and sensitive to ultraviolet light and the drug, mitomycin C. The occurrence of other mutations that lead to loss of exonuclease I and indirectly suppress mitomycin and uv sensitivity, but not recombination deficiency is reported. These mutations (called xonA) are cotransducible with his and closely linked with sbcB. Both sbcB and xonA mutant strains appear to have identical residual amounts of nuclease activity on single-stranded DNA. It is hypothesized that exonuclease I possesses a second activity other than its known ability to degrade single-stranded DNA from a 3′-OH terminus. Accordingly, sbcB mutations would alter the second activity while xonA mutations would not. (auth)

41081 STUDY OF THE ANTIMICROBIAL PROPERTIES OF RADIOACTIVE INJECTION PREPARATIONS IN RELATION TO THE PROBLEM OF INSURING THEIR STERILITY. Kotlyarov, L. M.; Konyaev, G. A. (Inst. of Biophysics, Moscow). Zh. Mikrobiol., Epidemiol. Immunobiol.; 48: 5-10(Aug 1971). (In Russian).

The sterility of radioisotope-labeled compounds used in humans was investigated. Conditions of preparation and sterilization methods were evaluated. The need for more rigid control of the sterility of preparations injected into human patients is stressed. (TSS)

41082 HEAT RESISTANCE OF TMV IRRADIATED WITH GAMMA RAYS. Suarez, Jose; Amaral, Horacio (Comision Chiliena de Energia Nuclear, Santiago). Rev. Med. Chile; 100: No. 2, 164-6(Feb 1972). (In Spanish).

The Tec thermolability of TMV in samples subjected to different doses of gamma rays from ^{60}Co was studied. The samples were infective for Nicotiana glutinosa, the test host, using one leaf for each sample. As control of the inactivation of the virus by gamma rays, the dose determined was 2.6×10^5 rad. Three series of samples were studied: one received no irradiation (control), one received 2.5×10^5 rad, and one received 5×10^5. Then the 3 samples were subjected to temperatures of 69°C ± 0.5 during periods of time that ranged from 0 to 250 minutes. The results show no significant differences for K (constant of thermic inactivation) in the 3 series. However, the samples irradiated with the 5×10^5 rad dose require further study since the number of local lesions induced by the active virus were scarce. This would suggest that at this level of irradiation the virus is inactivated more by gamma rays than by heat. (auth)

Radiation Effects on Plants (External Source)

Refer also to abstracts 41033, 41065, and 41309.

41083 (COO-1156-44) RESPONSE OF A NATIVE SHORT-GRASS PLANT STAND TO IONIZING RADIATION. Fraley, L.; Whicker, F. W. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). [1970]. 28p. (CONF-710501-51). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

An 8750 Ci Cs-137 source was installed in a native shortgrass plant stand near Nunn, Colorado. Treatments were chronic and semi-acute (30 da) seasonal exposures. Exposure rates varied from 650 R/hr to 7.8 mR/hr. The chronic exposure rate which resulted in a 50 percent reduction in diversity was continuing to decrease after two growing seasons. The stand appeared to be more sensitive in the late fall, intermediate in the spring and most resistant in the summer. The phenological development of some species was retarded by a chronic exposure of 1 R/hr. There was a significant effect on the total standing crop for all treatments and a significant effect on the grass-sedge component of the standing crop with the late fall showing the greatest sensitivity. The overall results indicated that the shortgrass community was relatively radioresistant in comparison to other plant communities. (auth)

41084 (COO-1689-7) RADIATION PASTEURIZATION OF FRESH MEATS AND POULTRY. Annual Report, February 15, 1970–June 14, 1971. Urbain, Walter M. (Michigan State Univ., East Lansing. Dept. of Food Science and Human Nutrition). Sep 1971. Contract AT(11-1)-1689. 26p. Dep. NTIS.

The process of radiation pasteurization of fresh meats and poultry was developed to permit centralized cutting of these products. No off-flavor was detected with irradiated, phosphate-treated beef. Dipping was the only satisfactory method for adding phosphates. Oxidation of fat resulted from the action of atmospheric oxygen and not irradiation. The addition of ascorbic acid helped control fat oxidation. (auth)

41085 INDUCTION OF MUTATIONS IN CULTIVATED RICE BY CHEMICAL AND PHYSICAL AGENTS. II. THE EFFECT OF M_1 DAMAGE AND M_2 MUTATIONS. Woo, Shiu-chu; Ng, Chi-ming; Tung, Ing-jiunn (Inst. of Botany, Taichung, Taiwan). Bot. Bull. Acad. Sinica (Taiwan); 12: No. 2, 66-73(Jul 1971).

Seeds of the Japonica variety of rice (Chianung 242) were treated with gamma irradiation (20 to 50 kR) and diethyl sulfate (pH 3, 7, 11) to study the sterility of M_1 plants and the morphological mutations of the M_2. The fertility of M_1 plants was affected by radiation treatments. It decreased with the increase of dose. Plants with poor fertility showed a higher mutation frequency. Chlorophyll mutations were found at the M_2 seedling stage. They were not associated with morphological mutations. Mutations induced by diethyl sulfate were less numerous than those induced by gamma irradiations. The number of chlorophyll mutations decreased with the pH level; however, the frequency of morphological mutations increased. No correlation was found between these two forms of mutations. (auth)

41086 STUDIES ON THE INDUCED MUTATIONS IN MEDICINAL PLANTS. I. SPECTRUM OF ADULT PLANT MUTATIONS IN ATROPA BELLADONNA. Kaul, B. L.; Bradu, B. L. (Regional Research Lab., Jammu, India). Planta Med.; 20: No. 3, 205-10(Nov 1971).

Seeds of Atropa belladonna were exposed to 35 kR of γ irradiation, and effects of irradiation were studied through M_1 and M_2 generations. Fifteen distinct adult plant mutations (macromutations) affecting such characters as growth habit, vigour, branching, shape and size of leaves, floral peculiarities as well as total alkaloid content were isolated in the M_2 generation. A description of these mutants is given and their use in improvement of belladonna discussed. (auth)

41087 NEW VARIETY OF RICE IS INDUCED BY X RAYS. Majumder, B. (Bose Inst., Calcutta). Phyton (Buenos Aires); 28: No. 2, 165-8(Sep 1971).

By the use of seed exposure to ionizing radiations (75 kR x-rays), one mutant (S.221) was isolated with 6 to 12 anthers, and 1 to 3 kernels, that breeds true. This mutant has been given a new varietal status as, Oryza sativa L. var. bosei, Majumder. Ionizing radiations have induced macromutants of taxonomic importance in cereals as reported for barley. A similar mutant that has been induced in rice by x-rays is reported here. (auth)

41088 EFFECTS OF SEED MOISTURE CONTENT, GAMMA RAYS, AND UNMODERATED FISSION NEUTRONS ON VARIOUS BIOLOGICAL END-POINTS IN BARLEY, HORDEUM VULGARE L. EMEND LAM. Shivashankar, Gurubasavappa. Knoxville, Tenn.; Univ. of Tennessee (1971). 136p. University Microfilms Order No. 72-15,549.

Thesis.

Seeds of the barley variety, Atlas 57, whose moisture content was equilibrated to 5.6, 7.4, 11.8 and 15.6 percent, were irradiated with gamma rays at 12, 24, 36, 48 and 60 kR and with fission neutrons at 190, 380, 570, 765 and 960 rads tissue equivalent in air. Seedling height, survival frequency, meiotic chromosome aberrations and seed fertility in the M_1 generation and the frequency of chlorophyll and viable mutations in the M_2 generation were studied. Varying the moisture content of the seeds modified the radiosensitivity following fission neutron as well as gamma irradiation, but in different ways. Considering mutation rate as the criterion, seeds with the highest moisture content showed maximum sensitivity following gamma rays, while seeds with the lowest moisture content were more sensitive to neutron irradiation. Varying the seed moisture content caused the mutation rate as well as mutation spectrum to vary with both kinds of radiations used. Neutrons induced a higher frequency and a wider spectrum of mutations than did gamma rays. The higher frequency of mutations observed with neutrons has been attributed to damage of more primordial cells of the embryo. Though all the biological end-points studied did not show the same kind of response, certain interesting correlations were observed between different criteria studied. High positive correlations were observed between seedling height and survival, chromosomal aberrations and mutation rate, chlorophyll mutation rate and viable mutation rate, and mutation rate and mutation spectrum. Speculated reasons for the differential radiosensitivity with varying preirradiation seed moisture contents, kinds of radiations used and usefulness of equilibration of seed moisture content in mutation breeding programs were discussed. (Diss. Abstr. Int., B)

41089 USE OF RADIATION INDUCED MUTANTS IN HYBRIDIZATION PROGRAMS: METHODS AND RESULTS. Bagnara, D.; Rossi, L.; Porreca, G. (CNEN, Casaccia, Italy). Genet. Agr.; 25: No. 3-4, 189-230(31 Dec 1971). (In Italian).

A series of crosses according to the diallel scheme was performed between the cv. Cappelli, four radioinduced short straw mutants of wheat from Cappelli and the american cv. Lakota. Selection in the segregating generations was carried out on the basis of a comprehensive evaluation concerning the more meaningful characters, namely: heading date, number of culms, main culm length, spike length, number of spikelets per spike, number of caryopses per spike, 1000 kernels weight, percentage of yellow berry. Each of them was properly weighed, according to its importance in determining the agronomic performance of the derived line. Particular emphasis was given, however, to selection for short culm, early heading time and high seed setting. (auth)

41090 MUTAGENESIS AND GENETIC IMPROVEMENT IN WHEAT. Bagnara, D. (CNEN, Rome). Genet. Agr.; 25: No. 3-4, 243-378(31 Dec 1971). (In Italian).

A review is made of the main aspects and problems of mutagenesis applied to the breeding of the most widely cultivated wheats (T. aestivum and T. durum). Features and type of action of the main physical and chemical mutagens are considered; a comparison is also made between the two classes of mutagens on the basis of the results so far achieved. Mention is then made of: methods of treatment; parts of plants which can be treated; growing of treated material in M_1, M_2, M_3 and further generations; data to be successively recorded. Methods of estimation of frequency of mutations and the problem of arising of chimerical tissues, together with its possible overcoming, are also discussed. Examination is made of some special effects of mutagens, namely: influence on recombination and linkage; induction of translocations and duplications; diploidization of polyploids; induction of haploids and aneuploids; genetic analysis of specific loci; induction of male sterility. Finally, results are reviewed concerning induction and utilization, either as varieties or in cross breeding programmes, of mutants for characters of agronomic interest. (auth)

41091 IONIZING RADIATION EFFECTS ON HIGHER PLANTS. Haber, Alan H. (Oak Ridge National Lab., Tenn. Univ. of Tennessee, Knoxville). pp 231-43 of Concepts in Radiation Cell Biology. /Whitson, Gary L. (ed.). New York; Academic Press Inc. (1972).

The causal interrelations among the various aspects of radiation injury in reducing growth and promoting senescence and death are diagrammatically summarized. Much of the growth inhibition is a consequence of mitotic inhibition, although systems are available for studying inhibition of cell growth per se in nondividing systems. Radiation seems to promote senescence by means of nuclear imbalance and growth inhibition, but not significantly by accelerating senescence in absence of growth, cell division, and nuclear imbalance. The role of cell division in radiation injury is not to increase intrinsic radiosensitivity, but to amplify the damage after irradiation by producing a nuclear imbalance that results from chromosome breakage and perhaps also by perpetuating somatic mutations in the progeny of mutated cells. In the absence of the many deleterious consequences of postirradiation cell divisions, seedlings showing complete lethality in the genetic sense can be surprisingly normal in the physiological sense. (auth)

41092 MODIFIKATSIYA EFFEKTA IONIZIRUYUSHCHEI RADIATSII U RASTENII. (Modification of the Effects of Ionizing Radiation on Plants). Dishler, V. Ya. (ed.). Riga; Izdatel'stvo Zinatne (1971). 200p.

Factors modifying the response of plants to ionizing radiations are discussed. Some of the topics included in the monograph are: recovery of fast neutron-irradiated plant cells; the use of quantitative genetic methods to determine the efficiency of mutagenic and protective factors; postradiation effects of ATP and cysteine on the cytogenetic effect of γ rays on Crepis capillaris; effects of indene compounds on frequency of chromosome aberrations induced in Crepis capillaris by γ rays and fast neutrons; morphological changes in the M_1 generation of irradiated plants; and the postradiation effects of ATP and cystine on the cytogenetic effects of fast neutrons on Crepis capillaris seeds. (E.R.B.)

41093 LIPOXYGENASE ACTIVITY OF MITOCHONDRIA IN IRRADIATED SPROUTS. Borisova, I. G.; Budnitskaya, E. B. (Inst. of Biochemistry, Moscow). Dokl. Akad. Nauk SSSR; 202: No. 1, 217-20(Jan 1972). (In Russian).

The effect of 1,000 R doses of x rays on internal cell localization of lipoxygenase in tissues of roots and etiolated leaves of pea shoots was studied. The lipoxygenase activity was determined by the specific oxidation reaction of exogenic linoleic acid, and was found to be dependent on the structural entity of the mitochondria and variable in accordance with the action of the ionizing radiation. (K.S.W.)

41094 DYNAMICS OF MERISTEM CELL POPULATIONS. Proceedings of a Conference Held at Rochester, New York, August 19-21, 1971. Miller, Morton W.; Kuehnert, Charles C. (eds.). Advances in Experimental Medicine and Biology. Volume 18. New York; Plenum Publishing Corporation (1972). 323p. $19.50. (CONF-710838).

Separate abstracts were prepared for six of the papers appearing in these proceedings. The other papers discuss the physiological and structural dynamics of meristems. (E.R.B.)

For abstracts of individual papers see: 41095–41100.

41095 CELL DIVISION, DEVELOPMENT, AND RADIATION INJURY. Haber, Alan H. (Oak Ridge National Lab., Tenn.). Advan. Exp. Med. Biol.; 18: 187-95(1972).

From Dynamics of meristem cell populations conference; Rochester, NY. (19 Aug 1971). See CONF-710838.

Much of the growth inhibition produced by ionizing radiation is a consequence of mitotic inhibition, although systems are available for studying inhibition of cell growth without division. Radiation seems to promote senescence by means of nuclear imbalance and growth inhibition but not significantly by accelerated senescence in absence of growth, cell division, and nuclear imbalance. The role of cell division in radiation injury is not to increase intrinsic radiosensitivity but to amplify radiation-induced damage by producing nuclear imbalance as a result of chromosome breakage and perhaps also perpetuating somatic mutations in the progeny of mutated cells. Another indication of the qualitative importance of cell division in the production of radiation injury comes from findings that, for growth inhibition after irradiation with neutrons, much of the high RBE results from a component requiring cell division. In the absence of the many deleterious consequences of postirradiation cell division, seedlings showing complete genetic lethality can be surprisingly normal physiologically. This last consideration underlies the use of radiation-induced mitotic inhibition in certain systems for studying the relation of cell division to morphogenetic, physiological, and biochemical aspects of plant development. (auth)

41096 SHOOT DRY WEIGHT OF THE SOYBEAN SEEDLING FOLLOWING GAMMA IRRADIATION: EFFECTS OF EXPOSURE, EXPOSURE RATE, AND SPLIT EXPOSURE. Constantin, M. J.; Killion, D. D. (Univ. of Tennessee, Oak Ridge). Advan. Exp. Med. Biol.; 18: 197-210(1972).

From Dynamics of meristem cell populations conference; Rochester, NY. (19 Aug 1971). See CONF-710838.

Shoot dry weight of the Hill soybean seedling was used in a number of experiments to study the effects of gamma radiation exposure, exposure rate, and split exposure. Shoot dry weight is influenced by exposure rate such that D_{50} was approximately either 3000 or 5000 R at rates of 50 and 10 R/min, respectively. Seedlings subjected to a split exposure had a greater shoot dry weight than did those exposed continuously. At 4000 R accumulated exposure, seedlings given a 30, 60, or 120-min period between exposures showed an increase in shoot dry weight associated with the duration of the radiation-free period. This response is consistent with the phenomenon of repair of radiation-induced injury. An initial exposure of 500 R increased the D_{50} value by 950 R in seedlings given a radiation-free period of 120 min. Also, an initial exposure of 500 R reduced shoot dry weight to 73% of control for seedlings subsequently exposed to 3000 R as compared to 3% of control for seedlings exposed to 3000 R continuously, i.e., without an initial exposure. This response is consistent with the phenomenon of induced protection. The mechanism(s) involved in the soybean seedling was not investigated. (auth)

41097 SOME PROBLEMS OF CHROMOSOMAL ABERRATION STUDIES IN MERISTEMS. Savage, John R. K.; Miller, Morton W. (Medical Research Council, Harwell, Eng. Univ. of Rochester, N. Y.). Advan. Exp. Med. Biol.; 18: 211-26(1972).

From Dynamics of meristem cell populations conference; Rochester, NY. (19 Aug 1971). See CONF-710838.

Both dormant and active root meristems are frequently used in the study of radiation cytology as if they were homogeneous cell systems. This assumption is very far from the truth, for heterogeneity is present with regard to cell type, cell stage, cycle and phase times, and the metabolic status of the cells. Moreover, the dormant root is dormant when irradiated but active when fixed for observation, and the mobilization process introduces additional complications not normally present in roots that have been growing for some time. The purpose of this paper is to discuss the consequences of heterogeneity for three aspects of the study of radiation induced chromosomal aberrations: the uniformity of radiosensitivity; the precision with which cells can be located in G_2; and the interpretation of yield-time curves for chromatid aberrations. (auth)

41098 SEED MERISTEMS AS RADIOBIOLOGICAL TEST SYSTEMS. Konzak, C. F.; Favret, E. A. (Washington State Univ., Pullman). Advan. Exp. Med. Biol.; 18: 227-49(1972).

From Dynamics of meristem cell populations conference; Rochester, NY. (19 Aug 1971). See CONF-710838.

In the dormant barley seed, the meristem that forms the first leaf is already differentiated into the blade and the sheath. The growth of the first leaf blade and first leaf sheath is sequential in that order. On the contrary, the coleoptile growth appears to be independent. Under the experimental conditions, growth of the first leaf blade was completed by the 6th or 7th day from planting, while the growth of the first leaf sheath was not completed until the 12th day. Mutagen treatment differentially alters the time of growth initiation and termination as well as the growth rate of the blade and the sheath of the first leaf. In the dormant seed, the meristem originating the coleoptile is less sensitive to mutagen treatments than the meristem initial of the first leaf. The blade and the sheath of the first leaf have different responses to mutagen treatments. The blade appears more sensitive in the lower dose range while the sheath is more sensitive in the higher dose range. At about 50% injury, the first leaf blade and sheath appear to respond differentially to neutrons as compared with gamma radiation and EMS. However, the coleoptile and first leaf sheath have similar reactions to the two radiations. The different parameters measurable on the seedling, i.e., the final length of the first leaf blade and the first leaf sheath, and the growth rate of each tissue may prove useful in distinguishing effects of different treatments applied to seeds. (auth)

41099 CONTRIBUTIONS OF SEED MERISTEMS TO RADIOBIOLOGY. Conger, B. V. (Univ. of Tennessee, Knoxville. UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Advan. Exp. Med. Biol.; 18: 251-70(1972).

From Dynamics of meristem cell populations conference; Rochester, NY. (19 Aug 1971). See CONF-710838.

Seeds of higher plants have been extensively used as a radiobiological test system to advance our knowledge on certain mechanisms, particularly the early events involving the production and decay of free radicals, by which ionizing radiations induce damage in living cells. Most of the information gained has come from studies involving different modifying factors. Oxygen and free radicals appear to be closely related in the induction of at least part of the radiation-induced damage. Seed water content and temperature appear to regulate radical mobility and hence the degree to which free radicals are available to react with oxygen immediately after irradiation or at some time thereafter. By manipulating seed water content and temperature, we can control the degree of free radical recombination and hence study the reaction of radicals and oxygen over a specified period of time during post-irradiation storage. Although it is certain that free radicals in combination with oxygen are responsible for a part of the biological damage caused by high energy photons, there may not be a simple 1 to 1 relationship. There appear to be more than one radiation-induced free radical component with at least one being quite stable and hydration-resistant. The stable radicals may be those not associated with oxygen-dependent damage and also induced primarily in the endosperm. Post-irradiation storage and soaking experiments in seeds of different species coupled with EPR studies might provide some answers to radical lifetimes and decay and also aid in the identification of radical species. (auth)

41100 RADIATION PROBES OF MAIZE MERISTEMS. Smith, H. H. (Brookhaven National Lab., Upton, N. Y.). Advan. Exp. Med. Biol.; 18: 271-91(1972).

From Dynamics of meristem cell populations conference; Rochester, NY. (19 Aug 1971). See CONF-710838.

Three sets of experiments are described. In the first, a 25 μ deuteron microbeam was used to mark regions in leaf primordia of dry maize seeds and in this way relative growth was measured for different leaf areas from seed meristems to mature plant organs. In the second, seeds irradiated with a wide range of doses of fission neutrons and of x rays were measured for various responses ranging from sublethal genetic effects to seedling lethality. Plant development, following reprogramming of the genotype by the treatment, proceeded along a highly predictable course to maturity, depending on dose and quality of radiation. In the third set of experiments, it was shown that the nuclei in different leaf primordia differ in size. On the basis of computed radiation target dimensions, this difference was also shown to involve distances along chromosome segments, suggesting differences in DNA compacture, and possibly in activity, in the different leaf primordia. (auth)

41101 RESPONSE OF SHORTGRASS PLAINS VEGETATION TO CHRONIC AND SEASONALLY ADMINISTERED GAMMA RADIATION. Fraley, Leslie Jr. Fort Collins, Colo.: Colorado State Univ. (1971). 188p. (COO-1156-45). University Microfilms Order No. 72-16,110.

Thesis.

In order to determine the effect of radiation on the structure of native shortgrass plains vegetation, a 8750 Ci ^{137}Cs source was installed on the Central Plains Experimental Range near Nunn, Colorado. The experimental area was divided into 6 treatment sectors, a control, 2 sectors for chronic exposure (irradiation initiated April 1969 and continuing as of August 1971), and one each for spring, summer and late fall seasonal semi-acute (30 day) exposures which were administered during April, July and December 1969, respectively. Community structure was measured by coefficient of community and diversity index. Yield was determined by clipping plots in September 1970 and visual estimates in September 1969 and 1970 for the grass-sedge component of the vegetation. Individual species sensitivity was determined by density data recorded in April, June and September of 1969 and 1970 and by a phenological index recorded at weekly intervals during the 1969 and 1970 growing seasons. The response of the vegetation was similar whether determined by coefficient of community or diversity with diversity being a more sensitive measure of effects. In the chronically exposed sectors, the exposure rate which resulted in a 50% reduction in these 2 parameters (CC50 or D50) was still decreasing the second growing season and was approximately 18 R/hr for the CC50 as of June 1970 and 10 R/hr for the D50 as of September 1970. For the seasonally exposed sectors, the late fall period (December, 1969) was the most sensitive, summer (July 1969) the least sensitive and spring (April 1969) intermediate with CC50 and D50 values of 195 and 90, 240 and 222, and 120 and 74 R/hr for the spring, summer and late fall exposed sectors, respectively. Yield and density data indicated a rapid revegetation of the spring and summer exposed sectors during 1970 as a result of an influx of invader species such as Salsola kali tenuifolia, Chenopodium leptophyllum and Lepidium densiflorum and the reappearance of perennials with underground perennating organs such as Lygodesmia juncea, Gaura coccinea, and Oenothera coronopifolia. The most sensitive indicator of radiation damage was the phenological index with a chronic exposure rate of 1 R/hr delaying the development of Tradescantia occidentalis and Opuntia polyacantha. The shortgrass plains vegetation appears to be one of the most resistant community types studied to date with semi-acute exposures of 45 to 75 kR necessary to decrease diversity to 50% of the control value. (Diss. Abstr. Int., B)

41102 EFFECT OF PRE-SOWING GAMMA IRRADIATION OF SEEDS ON THE COMPOSITION OF RICE (VAR. IR-8 AND NSJ-98) GRAINS. Garg, O. K.; Tiwari, B.; Srivastava, M. P.; Bhattacharya, M. K. (Banaras Hindu Univ., India). Labdev (Kanpur); 9: No. 2, 101-3(1971).

Rice seeds were gamma-irradiated from a ^{60}Co source at 1, 3, 5, and 7 KR and grown in pot cultures. Grains were analyzed for total carbohydrates, total crude proteins, and NPK contents. It was found that irradiation influenced the composition of the grain of both varieties. Lower intensities of radiation elevated the total carbohydrates, total N, and total crude proteins, while higher intensities produced inhibitory effects. Changes in the P and K contents of irradiated seeds were insignificant. Inhibitory effects were observed at doses above 3 KR. It is suggested that gamma radiation might be used for improvement of the nutritional value of rice. (Indian Sci. Abstr.)

41103 USE IN PLANT BREEDING OF ACUTE, CHRONIC, OR FRACTIONATED DOSES OF X-RAYS OR FAST NEUTRONS AS ILLUSTRATED WITH LEAVES OF SAINTPAULIA. Broertjes, C. Wageningen, Netherlands; Centre for Agricultural Publishing and Documentation (1972). 83p.

Thesis.

The survival of irradiated leaves of the African violet, Saintpaulia ionantha, production of adventitious plantlets at the base of the petiole, and mutation frequency were studied. The differences between unfiltered x rays from a 250/25 deep therapy and apparatus and fast neutrons from a degraded fissions spectrum was slight and sometimes negligible. A striking dose rate effect was observed, especially with x rays. In fractionation experiments a protective mechanism was induced in the leaves by pre-irradiation with either type of radiation. This mechanism reached a maximum after 8 to 12 h. Then the extent of the protection was equivalent to 3 krad x rays or 1.5 krad fast neutrons after a single pre-treatment with the optimum initial dose of 500 rad, x rays or fast neutrons. A 10 to 15 fold irradiation with this dose separated by 8 h intervals induced a protection of 6 to 7 krad x rays or 3 to 4 krad fast neutrons. Several of the treatments result in a higher number of mutants per 100 irradiated leaves compared with the optimum acute dose of 3 krad x-rays or 1.5 krad fast neutrons. (auth)

41104 MORPHOLOGICAL AND CYTOLOGICAL EFFECTS OF PRE- AND POST-IRRADIATION TREATMENTS WITH DIFFERENT CHEMICALS IN TOMATO. Bose, S.; Bose, M. S. (Univ. of Calcutta). Nucleus (Calcutta); 14: No. 1, 9-14(Jun 1972).

Pre- and post-irradiation treatment of dry seeds of tomato (Lycopersicum esculentum) with distilled water, colchicine (0.2%), diethyl sulfate (saturated soln.) and triethylamine (0.5%), produced variant types with fasciation and bifurcation of stem and dwarf plants with leaf modifications and with floral abnormalities. Mitotic abnormalities included fragments at metaphase and fragments and bridges at anaphase. Meiotic irregularities included univalents, trivalents and quadrivalents at metaphase I and laggards, unequal separation of chromosomes, bridges with or without fragments at anaphase I. No polyploids were, however, observed after pre- or post-irradiation treatment with colchicine. The importance of translocations and inversions has been pointed out. (auth)

41105 EFFECT OF IONIZING RADIATIONS AND CHEMICAL MUTAGENS ON CHIASMA FREQUENCY IN SORGHUM. Sree Ramulu, K. (Tamilnadu Agricultural Univ., Coimbatore, India). Cytologia (Tokyo); 36: No. 3, 543-51(Sep 1971).

The effect of ionizing radiations (x- and gamma rays) chemical mutagens (EMS, MMS, DES and NEU), and combination treatments on chiasma frequency of chromosomes was studied in the M_1 plants of three varieties (Co 11, Co 12 and Co 18) of Sorghum ($2n = 20$) raised from the treated seeds. All the treatments caused a decrease in chiasma frequency compared to control. There was a marked reduction in the number of bivalents with three chiasmata, while the number of bivalents with one chiasma increased following mutagen treatments. There were differences in the action of different mutagen agents on one hand and a differential response of the varieties on the other. The treatments with chemical mutagens caused a higher reduction in chiasma frequency than radiation treatments. The combination treatments of gamma rays and DES caused a higher reduction, while x rays + NEU increased the chiasma frequency compared to the single treatments. The factors, namely the terminalization, structural changes, univalent formation and the process leading to chiasma formation, are discussed in the light of the present results. (auth)

41106 GENETIC EFFECTS OF GAMETOPHYTE IRRADIATION IN BARLEY. II. FREQUENCY AND TYPES OF MUTATIONS DINDUCED. Devreux, M.; Donini, B.; Scarascia Mugnozza, G. T. (CNEN, Casaccia, Italy). Radiat. Bot.; 12: No. 2, 87-98(May 1972).

Spikes of barley were acutely irradiated (1500 R, 93 R/hr) in gamma field-(^{60}Co source) at different developmental stages of their gametophytes. M_1 plants were raised following pollination with irradiated male gametophyte on unirradiated stigma, pollination with unirradiated pollen on irradiated female gametophyte, and both irradiated male and female gametophytes. A total of 2396 M_2 progenies coming from one or two spikes per each M_1 plant were analyzed in M_2 for chlorophyll, morphological and sterile mutations. The total mutation frequency, expressed as number of segregating progenies per 100 M_1 plants analyzed, was 27 · 23, 18 · 03 and 8 · 34 after irradiation of both, and male and female gametophytes, respectively. Moreover, the spectrum of chlorophyll and morphological mutations induced after irradiation of male, female and both male and female gametophytes does not allow the detection of any large difference among the different treatments. The highest mutation frequency was reached in the progeny of M_1 plants which showed a fertility reduced to 40 to 50% of the control value. Furthermore, the M_1 sterility, the total mutation frequency and the mutation types show insignificant differences, regardless of the degree of the development of the irradiated gametophytes. These results show that irradiation of both gametophytes, which gives the highest frequency of mutations without chimerism, is a very simple method and a valid tool for breeding. Among the mutants isolated in this experiment was a very early type (blooming 25 days earlier than control); it has been increased due to its agronomical interest. (auth) (UK)

41107 EFFECTS OF ULTRAVIOLET IRRADIATION ON PRODUCTION OF AFLATOXINS BY ASPERGILLUS FLAVUS LINK EX. FRIES. Yang, C. Y. (Univ. of Kentucky, Lexington). Radiat. Bot.; 12: No. 2, 105-11(May 1972).

A toxigenic Aspergillus flavus isolate was selected to study the effects of uv irradiation on aflatoxin production. The loss of conidial pigmentation and aflatoxin production resulting from an earlier uv irradiation treatment was reversed by prolonging the post-uv incubation period. Reduction in aflatoxin from cultures was 10.6% in response to 13.39×10^3 erg/mm^2 of near-uv and 42.9% in response to 21.87×10^3 erg/mm^2 of far-uv treatment. When aflatoxin extracts were irradiated directly with uv, the concentration of aflatoxin decreased proportionally with increase of far-uv dosage, but increased proportionally with increase of near-uv dosage. However, after uv irradiation, neither degradation nor changes in the characteristics of aflatoxin could be detected by thin-layer chromatography or uv spectrophotometry. (auth) (UK)

41108 COMPARATIVE SENSITIVITY TO GAMMA RADIATION OF CONIDIA, MYCELIA, AND SCLEROTIA OF BOTRYTIS CINEREA. Sommer, N. F.; Fortlage, R. J.; Buckely, Patricia M.; Maxie, E. C. (Univ. of California, Davis). Radiat. Bot.; 12: No. 2, 99-103(May 1972).

The multicellularity and indeterminate growth of fungus propagules, other than spores, preclude studies utilizing familiar bacteriological techniques in which surviving fractions of cell populations are determined. To compare the sensitivity to gamma radiation of conidia, mycelia, and sclerotia of Botrytis cinerea, an end-point technique was utilized in which the dose preventing postirradiation out-growth from 50% of samples of various sizes was determined. Similar samples were utilized to determine dry-weights and contents of protein and DNA, each of which was used as a measure of sample size. Regardless of index of sample size utilized, young mycelia and sclerotia were more resistant and mature mycelia more than conidia. (auth) (UK)

41109 GAMMA RADIATION EFFECTS ON BIOCHEMICAL COMPONENTS OF PUERTO RICAN MANGOS. Cuevas-Ruiz, Jose; Graham, H. D.; Luse, R. A. (Univ. of Puerto Rico, Mayaguez). Contract AT(40-1)-1833. J. Agr. Univ. Puerto Rico; 56: No. 1, 26-32(Jan 1972).

The effects of gamma radiation were investigated on the content of ascorbic acid, total carotenoids, total carbohydrates, and titratable acidity in five varieties of mangos grown in Puerto Rico. Irradiation with 75-Krad doses did not significantly influence biochemical components. Subsequent changes were related closely to delay in fruit ripening, and reduction of fungal spoilage, effected by the radiation pasteurization. Radiation at the 75-Krad level extended shelf life to 7 days. (auth)

41110 GAMMA IRRADIATION OF SEEDS BEFORE SOWING FOR INCREASING THE CROP CAPACITY OF AGRICULTURAL PLANTS. Berezina, N. M. (Inst. of Biological Physics, Moscow). Izotopy SSSR; No. 21, 8-10(1971). (In Russian).

A short review is given of work on the stimulation of seeds of agricultural plants by ionizing radiation. The results of many years of field studies on potatoes, sugar beets, cabbage, carrots, and radishes are described. (tr-auth)

41111 EFFECT OF LOW RADIATION DOSES ON BARLEY AND WHEAT. Suess, A. Bayerische Landesanstalt fuer Bodenkultur, Munich); Bretschneider-Hermann, B. Stimulation Newslett.; No. 2, 36-44(1971).

A report is given on various experiments performed since 1965. During the first series, seeds were irradiated with doses of 1 to 100 R. Later on, the conditions of climate were varied in order to get higher grain yields, and higher doses (25 to 400 R) were applied. The grain and straw yields were compared, showing different results. After irradiation of dry seeds or plants of various development stages, different rates of increase of the yield were found. The irradiation of soaked seeds, however, caused a yield reduction. (INIS)

41112 RECOMBINATION IN RELATION TO ULTRAVIOLET SENSITIVITY IN CHLAMYDOMONAS REINHARDI. Rosen, Howard; Ebersold, W. T. (Univ. of California, Los Angeles). Genetics; 71: No. 2, 247-53(Jun 1972).

A mutant strain of Chlamydomonas reinhardi which is uv sensitive as a result of a single-gene chromosomal mutation has also been found to exhibit reduced recombination. In crosses homozygous for the mutant allele, a reduction in recombination frequency was demonstrated in two different linkage groups and in three different genetic backgrounds. Thus a single mutation affecting uv sensitivity also has a possible effect on recombination. Such a mutant could be analogous to the rec$^-$ mutants discovered in E. coli and as such be useful in the study of recombination mechanisms. Three additional uv-sensitive isolates were tested. Recombination was not altered in these mutant strains. (auth)

41113 EFFECTS OF LOW ENERGY X RAYS ON MEMBRANE POTENTIAL, MEMBRANE RESISTANCE, AND ACTION POTENTIAL OF NITELLA FLEXILIS. Roettinger, E. M.; Hug, O. (Univ., Munich. Gesellschaft fuer Strahlen- und Umweltforschung, Munich). Radiat. Res.; 50: No. 3, 491-503(Jun 1972).

Immediate alterations of membrane potential and membrane resistance, measured with microelectrodes and clamped current impulses, were induced in Nitella cells by exposure rates from 6 to 120 kR/minute and exposures above 20 kR. The membrane resistance decreased simultaneously with the first wave of depolarization, Thirty kR/minute stimulated action potentials in the majority of investigated internodes. An initially increased chloride permeability is probably responsible for these effects. Radiation reduced the temperature coefficient of the membrane resistance. This might be linked to effects on the active transport systems. (auth)

Radiation Effects on Animals (External Source)

Refer also to abstracts 41033, 41063, and 41497.

Man

Refer also to abstracts 40616 and 40839.

41114 (BNWL-SA-4172) HIT THEORY FOR LOW-LET RADIATION. Roesch, W. C. (Battelle Pacific Northwest Labs., Richland, Wash.). 10 Apr 1972. Contract AT(45-1)-1830. 10p. (CONF-720530-2). Dep. NTIS.

From twentieth annual meeting of the Radiation Research Society; Portland, OR (14 May 1972).

Based on the author's previous description of how time-dependent phenomena could be included in a hit theory, an approximation of good accuracy is described that permits ready application of the hit theory to low-LET radiations. Proceeding from the basic survival equation of the author's theory, an equation for survival involving a high number of hits, characteristic of low-LET radiations, is derived. The dependence of survival, in the case of low-LET radiations, on dose rate and on the time between fractions is discussed. (E.R.B.)

41115 (CONF-711029-1) CHANGING ROLE OF THE HEALTH PHYSICIST. Morgan, Karl Z. (Oak Ridge National Lab., Tenn.). [1971]. 18p. Dep. NTIS.

From Health physics symposium; Upton, N. Y. (28 Oct 1971).

After some brief historical remarks on health physics, the hazards in medical use of ionizing radiation are mentioned. The need for more health physicists is discussed. The new radiation sources, some of them non-ionizing, which health physicists must be concerned about, are discussed. (M.H.R.)

41116 (CONF-720105-1) NEED FOR RADIATION PROTECTION. Morgan, Karl Z. (Oak Ridge National Lab., Tenn.). [1971]. Contract W-7405-eng-26. 28p. Dep. NTIS.

From Conference of Radiologic Technologists; Durham, N. C. (22 Jan 1971).

The hazards in medical use of the diagnostic x-ray are discussed at length. A case is presented for improved techniques and lowering the accumulated dose from this source. (M.H.R.)

41117 (CONF-720503-1) HEALTH PHYSICS MEASURES TO IMPLEMENT NEW USAEC REGULATIONS RELATING TO RADIATION EXPOSURE OF THE GENERAL PUBLIC. Morgan, Karl Z. (Oak Ridge National Lab., Tenn.). [1971]. Contract W-7405-eng-26. 5p. Dep. NTIS.

For Presentation at second European congress on radiation protection; Budapest, Hungary (3 May 1972).

A few remarks on changing opinions on radiation exposure and factors to be considered relative to nuclear power reactors are included. It is suggested that all AEC operations should be subjected to the same radiation surveillance as power reactors. Procedures for health physicists are discussed. (M.H.R.)

41118 (COO-3013-19) RADIATION AND THE PUBLIC HEALTH. Fabrikant, Jacob I. (Connecticut Univ., Farmington. Dept. of Radiology). [nd]. Contract AT(30-1)-4244. 13p. (CONF-710225-1). Dep. NTIS.

From Johns Hopkins Medical and Surgical Association radiology conference; Baltimore, MD. (26 Feb 1971).

The present evidence suggests that insofar as somatic mutations are concerned, acute leukemia and chronic myeloid leukemia are the long term effects of greatest significance in irradiated human populations. From the data on the dose response relationship, there appears at present no alternative but to assume a linear relationship between dose and effect. For some types of somatic effects there may very well be a threshold dose but not for the induction of leukemia and of many other types of neoplasm, and it is likely that there is a finite risk even at the lowest doses. In other words, as appears to be the case for genetic effects, one has to assume that there is no safe dose for somatic effects, such as radiation neoplasia. It follows, therefore, that the setting of any maximum permissible radiation level or radiation guide is essentially an arbitrary procedure. The gap between our scientific knowledge and our social demands is widening, and the practical information is seriously lacking. It is now assumed that any exposure to radiation carries some risk of deleterious effects. Radiation and the public health, when it involves the public health, becomes a sociological and political problem possibly to be decided by men of business and law, and not just an exercise in statistical theory or laws of chance. Unless man wished to dispense with medical and industrial activities which invariably involve exposures to ionizing radiations, he must recognize that some degree of risk exists. In the evaluation of risks from irradiation it is necessary to limit the radiation dose to a level at which the risk is acceptable both to the individual and to his society, if he wishes to continue to derive benefits from such activities. (auth)

41119 (COO-3013-54) MANAGEMENT OF RADIATION INJURY IN MAN. Fabrikant, Jacob I. (Connecticut Univ., Farmington. Dept. of Radiology). [nd]. Contract AT(11-1)-3013. 13p. Dep. NTIS.

The diagnosis and treatment of acute radiation injury in man are discussed. With the increasing use of nuclear energy and other sources of radiation, the possibility of overexposure extends to an increasing number of people. Some radiation accidents may occur in spite of increasing knowledge and the use of rigid safety precautions. Past experience suggests that such accidents will be rare and that the very rarity will permit some overexposures to go unrecognized. Nevertheless, there is ample clinical evidence thus far that the survival rate of those persons exposed to radiation in the lethal range can be expected to increase significantly with commonly available therapeutic means and agents. There is nothing unique in clinical medicine about management of the patient acutely injured by irradiation, since patient management should be based on the symptoms and results of clinical laboratory tests. Thus, the treatment of human radiation injury is governed by the same basic considerations that influence the management of any other clinical problem, namely, the history, the clinical picture, laboratory data, and estimated magnitude and distribution of exposure to the injurious agent. (auth)

41120 (JPRS-56030) SPACE BIOLOGY AND MEDICINE, VOL. 6, NO. 2, 1972. Translation of Kosm. Biol. Med.; 6: No. 2, 3-91(1972). 143p. NTIS.

Articles are included on the selection and training of cosmonauts; evaluation and analysis of accumulated data to facilitate the ongoing transition from orbital to interplanetary flights; research aimed at guaranteeing safety on long flights and reliability of the human component of the man-spaceship system; space psychology and physiology; environmental problems and control (spacecraft habitability, effects of radiation and weightlessness, etc.) and telemetry. Dogs were used in experiments on effects of gamma radiation on immunity and erythrocyte reserve. (H.L.W.)

41121 (LA-DC-72-355) POSSIBLE USE OF NEGATIVE PIONS AND NEGATIVE MUONS IN THERAPEUTIC AND DIAGNOSTIC MEDICINE. Rosen, Louis (Los Alamos Scientific Lab., N. Mex.). [1971]. Contract W-7405-eng-36. 32p. (CONF-720428-1). Dep. NTIS.

From thirty-second annual congress and scientific exhibition meeting; London, England (20 Apr 1972).

The possible uses and the advantages of using negative pions and negative muons in diagnostic and therapeutic medicine are discussed. Negative pions and negative muons live long enough to be stopped in matter and to form pionic and muonic atoms, respectively. The strong pion-nucleon interaction gives rise to nuclear disintegrations with resultant large, localized deposition of high specific ionization radiation, and is thus a potential application to radiotherapy. The weak interaction of muons with nuclear matter inhibits large energy depositions at the end of their range and permits the muonic atom to live long enough for transitions to occur to the lowest atomic orbits about a capturing nucleus, with corresponding emission of characteristic and energetic x rays, thus endowing the muon with its potential in diagnostic medicine. (E.R.B.)

41122 (NYO-3970-31) STUDIES ON THE EFFECTS OF DIAGNOSTIC X-RAY EXPOSURE LEVELS TO THE FETUS. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore, Md. Dept. of Radiological Sciences). [nd]. Contract AT(30-1)-3970. 39p. Dep. NTIS.

A review is presented of experimental and clinical studies related to the effects of low radiation doses on the maturation of the developing human ovum and fetus. Sources of ionizing radiation are discussed with emphasis on natural background radiation and medical exposure to x radiation. A consideration of problems of irradiation during pregnancy includes genetic hazards to the ovaries of adults and fetuses and it is emphasized that the risks of medical exposure to x rays are most significant for maturation of the human ovum, organogenesis of the fetus, and the induction of leukemia and other childhood cancers. The correlation of radiosensitivity with various stages of meiosis during oogenesis is discussed. A survey of mothers of 1200 children showed that diagnostic radiological examinations of pregnant women increased the risk of subsequent childhood leukemia and malignancy. Other topics reviewed are: genetically significant dose levels from diagnostic x rays; ICRP recommendations for radiological examinations; artificial radioactivity; radioactive fallout from nuclear weapons testing; and nuclear reactors. (H.L.W.)

41123 (ORNL–4795) APPLIED HEALTH PHYSICS AND SAFETY ANNUAL REPORT FOR 1971. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 59p. Dep. NTIS.

There were no external or internal radiation exposures to personnel during 1971 which exceeded the standards for radiation protection as defined in AEC Manual Chapter 0524. There were no accidental releases of gaseous or liquid waste from the Laboratory which were of a level that required a report to the AEC. Ten unusual occurrences involving radioactive materials were recorded during 1971. The safety record for 1971 was very good. As compared to 1970, there were 12.5 percent fewer medical treatment cases, 22.5 percent fewer serious injuries, and 20 percent fewer disabling injuries. The disabling injury frequency rate for 1971 was 0.61 as compared with a frequency rate of 0.76 for 1970. (auth)

41124 (RLO–1780-33) EFFECTS OF IONIZING RADIATION ON THE TESTICULAR FUNCTION OF MAN. 1 Year Progress Report, May 1972. Heller, Carl G. (Pacific Northwest Research Foundation, Seattle, Wash.). May 1972. Contract AT(45-1)-1780. 22p. Dep. NTIS.

Pathological changes in the human testis observed from 26 to 1904 days following exposure to x radiation at doses ranging from 8 R to 600 R are described. Changes in cell morphology and ultrastructure were observed microscopically in tissue samples obtained by biopsy or during autopsy. (C.H.)

41125 (RLO–1780-34) EFFECTS OF IONIZING RADIATION ON THE TESTICULAR FUNCTION OF MAN. 9 Year Progress Report. Heller, Carl G. (Pacific Northwest Research Foundation, Seattle, Wash.). May 1972. Contract AT(45-1)-1780. 61p. Dep. NTIS.

Cytological and hormonal research achievements to date (May, 1972) include: method for quantitation of germinal and Leydig cells; x-ray confirmation of timing of spermatogenesis in normal man; quantitative response of germinal cell types to irradiation at doses of 10 to 600 R; classification of dose-response for germinal cell types; evaluation of effects of biopsy on sperm count; ultrastructural description of form types of human spermatogonia; description of human germinal cells by light microscopy; determination of ductular transport time of mature human spermatozoa; quantitative inspections of spermatogonial recovery following irradiation; discovery of unique nature of human spermatogonial recovery; determination of duration of each cell type; immediate effect of x rays on sperm morphology; correlation between gonadotropins and testicular function; status of urinary and plasma FSH and ICSH following irradiation; radioimmunoassay of plasma ICSH; depression of Leydig cell function following irradiation at high doses; and effects of exogenous human chorionic gonadotropins on function of irradiated Leydig cells. (E.R.B.)

41126 SCINTIGRAPHIC FINDINGS MADE ON THE LIVER, AFTER PARTIAL IRRADIATION WITH ^{60}Co. Brase, A.; Bockslaff, H.; Kaumann, M. (Medizinische Hochschule, Hanover). Strahlentherapie; 143: No. 1, 41-7(Jan 1972). (In German).

Scintigraphic observations were made on 38 patients suffering from malignant diseases of the lymphatic system, by application of radioactive gold (^{198}Au) and bromsulphthalein (^{131}iodine), after partial irradiation of the liver in the course of telecobalt therapy. Functional changes of the liver and of the reticulo-endothelial system as a reaction to irradiation in this manner can be diagnosed earlier and more reliably than by the usual liver function tests. From the two cell types of the liver, Kupffer's cells are more radiosensitive. First signs of a radiation participation of the liver, in the sense of a reduced activity concentration, can be found in the hepato-scintigram after a focal dose of about 3000 rd, administered in fractionated single doses of 300 rd over 28 days. A total blockage of the phagocytic capacity of the RES in the region of irradiation is observed nearly always after a focal dose of 4500 rd. Control scintigrams—in part over several years—prove that these changes are reversible after a focal dose of 5000 rd, under the premises that only a partial irradiation of the liver was performed. The degree and fastness of restitution of the RES depend on the administered dose, the localization and the size of the irradiated volume. (auth)

41127 CHANGES IN THE CONCENTRATION OF FREE AMINO ACIDS IN THE BLOOD PLASMA OF PATIENTS UNDER RADIOTHERAPY (WITH CONSIDERATIONS OF STATISTICAL RESULTS). Hahn, K.; Ladner, H.-A.; Jesdinsky, H.-J. (Univ., Mainz. Univ., Freiburg i. B.). Strahlentherapie; 143: No. 4, 386-95(Apr 1972). (In German).

In 26 female and 10 male tumor patients, the concentrations of free amino acids in the blood plasma were examined before, during 15 days following, and after termination of radiotherapy with ^{60}Co, and compared with the values found in 9 female and 9 male healthy persons. Whereas the plasma concentrations of some amino acids (especially leucine, valine and alanine) are lower in tumour patients than in healthy persons, before starting the radiotherapy, the values of several amino acids (especially phenylalanine, tyrosine, leucine and proline) decrease in the course of and towards the end of the daily ^{60}Co local irradiation. Some particular amino acids only show none or slight changes during the radiotherapy. The discussion of these results takes into consideration the corresponding observations, so far mainly made on small animals, and the possible exogenous and endogenous influences on this section of the amino acid metabolism described in literature. (auth)

41128 SO-CALLED LYMPHATIC EDEMA OF THE LOWER EXTREMITY FOLLOWING GYNECOLOGICAL RADIOTHERAPY. Vahrson, H. (Univ., Giessen, Ger.). Strahlentherapie; 143: No. 2, 172-8(Feb 1972). (In German).

In 14 cases showing augmented circumference of one or both lower extremities after, in two cases even before therapy of a genital cancer, besides a partial or total blockage of the lymph vessels, caused by metastases, a blockage of single or of all the great pelvic veins was also found. Lymphatic and venous blockage as well as ureteral obstruction on one side are an almost sure sign for metastases, even in case of negative gynecological findings. At increased circumference of the lower extremity, the lymphography must be completed by an examination of the veins, optimally by ossovenography. The term secondary lymphatic edema, used in connection with a female genital cancer, should be replaced by the term combined obstructive edema, which also includes the involvement of the venous circulation system. (auth)

41129 GENERAL REACTION OF THE BODY IN COMBINED RADIATION AND TRAUMATIC INJURIES. Pantelic, Dragoljub; Radotic, Milorad (Boris Kidric Inst. of Nuclear Science, Vinca, Yugoslavia). Vojnosanit. Pregl.; 28: No. 6, 297-304(Jun 1971). (In Serbo-Croatian).

Radiation injury is defined, the types of such damage are classified, and other types of injury, such as traumatic shock, are discussed. The injury syndrome resulting from a combination of radiation and other types of injury depends on the nature of the additional insult (thermal, mechanical, or other) and the chronology of events, both the time that has elapsed after the irradiation and the time at which the further injury occurs. Extrapolation of results of animal studies to the human is risky. (26 references) (TTT)

41130 COMPARATIVE ABSORBED DOSES IN INTRAORAL PERIAPICAL RADIOGRAPHY. Weissman, Donald D. (Univ. of California, Los Angeles). J. S. Calif. State Dent. Ass.; 39: 886-92(Nov 1971).

The reduction of radiation in the dental office should be of concern to all practitioners. The development of a technique to provide maximum diagnostic information with a minimum of radiation hazard is described. (auth)

41131 IONIZING RADIATION AS A FACTOR OF ENVIRONMENT IN THE REPAIR LABORATORIES OF THE CIVIL AIR TRANSPORT. SECOND COMMUNICATION. Vasilev, G.; Filev, G.; Dermendzhiev, Kh.; Vitev, V.; Karadzhov, A. Transp.-Med. Vesti; 2: No. 16, 32-6(1971). (In Bulgarian).

The characteristics of radiation fields in the laboratories for equipment repair and for trial and repair of board locators were studied by measuring beta- and gamma radiation, intensities of super-frequency (SF) electromagnetic field, soft roentgen radiation, and radioactive contamination of hands, clothes, and work surfaces. The following results were obtained: External irradiation of the staff during repair and maintenance of aircraft supplied with board dials painted with radioactive light emitting dyes or control devices using radioactive isotopes is far below the maximal admissible dose for occupational irradiation. The levels of radioactive contamination of the working tables and hands of workers employed with the repair of devices painted with light-emitting radioactive dye vary within broad limits and exceed many times the maximal admissible ones. Workers employed with repair and tuning of radiolocators are in a SF electromagnetic field where the stream power is quite high and may reach dangerous levels. Soft x-ray treatment generated from modulator lamps and spreading with the equipment case removed has an average energy of 25 keV. The power of exposure doses that varies in changing the distance from the source is not great. Measures are suggested guaranteeing radiation security. (INIS)

41132 VESICAL NEOPLASMS OCCURRING AFTER RADIATION TREATMENT FOR CARCINOMA OF THE UTERINE CERVIX. McIntyre, Donald; Pointon, Robert C. S. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). J. Roy. Coll. Surg. Edinburgh; 16: 141-6(May 1971).

A series of cases of tumors of the urinary bladder occurring in women treated for carcinoma of the uterine cervix by irradiation is reported. The latent period between the treatment of the uterine lesion and the development of the vesical tumor in 10 cases was such that they might be considered radiation-induced. The incidence of vesical neoplasms in this group is higher than in a comparable group of women, but the hazard is not great. The problems of diagnosis and treatment are discussed. (auth)

41133 SOME ASPECTS TO THE INTERRUPTION OF PREGNANCY FROM THE RADIOLOGIST'S POINT OF VIEW. Boehringer, V. (Zentralinstitut fuer Radiologie, Karl-Marx-Stadt, Ger.). Radiobiol.-Radiother.; 13: No. 2, 187-91(1972). (In German).

The indication for the interruption of human pregnancy after radiodiagnostic as well as after radiotherapeutic exposure is discussed. It is shown that there is no reason for an interruption of pregnancy if x radiation is properly used for diagnosis in pregnancy. The possible presence of damage to the mother's germ does not require an interruption. The possible damage to the fetus, as may occur with 25 to 50 R, should always be an indication for interruption. (auth)

41134 PROBLEMS OF PROTECTION IN THE USE OF SEALED RADIOACTIVE SOURCES IN CONTACT, INTERSTITIAL, AND INTRACAVITARY CURIE-THERAPY. Farulla, A. (Univ., Sassari, Italy); Tosi, G.; Botturi. Minerva Fisiconucl.; 15: No. 4, 168-76(Oct-Dec 1971). (In Italian).

Several radioactive sources, natural and artificial, are used for contact, intracavitary, and interstitial therapy. Methods for reduction of the radiation dose to medical personnel are discussed. The use of afterloading techniques is stressed. (TSS)

41135 EFFECT OF RADIATION THERAPY ON THE BLOOD ZINC CONTENT IN PATIENTS WITH TUMOR OF THE HYPOPHYSIS. Fridlyand, I. B.; Ginzburg, M. B.; Merkova, M. A.; Klimenko, A. A. (Scientific-Research Inst. of Roentgeno-Radiology, Moscow). Med. Radiol.; 17: No. 4, 9-12(Apr 1972). (In Russian).

Results of investigations on the blood zinc levels in 56 patients following radiation therapy of tumors are reported. They elucidate the dependence of the blood zinc contents upon localization of the neoplasm and exposure fields. A parallel study of the blood zinc content in 46 patients with a tumor of the esophagus and in 32 patients with a new growth in the stomach was carried out. The experimental part of the work concerned with the distribution of zinc in the endocrine glands included investigations made on 276 rats. The blood zinc levels in patients with a tumor of the hypophysis was found to be elevated, whereas that in patients with the new growth localized in the esophagus or the stomach remained unchanged. Radiation therapy contributed to normalization of the blood zinc levels in patients with hypophyseal tumors and produced no effect in patients suffering from new growths in the esophagus and stomach. Experimental studies into distribution of zinc in the endocrine glands showed the hypophysis to contain nearly twice as much zinc as compared with any other organs. (auth)

41136 LATE RADIATION NECROSIS OF THE BRAIN. Badmaev, K. N.; Chaika, T. V. (Leningrad Scientific-Research Inst. of Neurosurgery). Med. Radiol.; 17: No. 4, 12-18(Apr 1972). (In Russian).

Autopsy findings made in 53 patients subjected to megavolt x irradiation for malignant tumors of the brain revealed 10 cases of cerebral necrosis. A dosimetric analysis of the necropsy material was done by superposing upon brain sections maps showing the isodose distribution of energy. The radiation necrosis of the brain developed within the time period of 4 months to 2 years after irradiation. Originating within the area of maximal radiation action the necrosis focus implicated the tumor and the contiguous cerebral tissues. The boundaries of the radiation lesion correspond in the main to those of irradiation. The dependence of the degree of radiation lesion upon the dosage rate is confirmed. An inference as to the danger of a forced multi-course irradiation is made. Attention is called to the need of a more cautious irradiation of the brain divisions displaying an elevated radiation susceptibility. (auth)

41137 STUDY OF THE ^{51}Cr LABELED ALBUMIN METABOLISM BY RADIOMETRY OF THE WHOLE BODY AND ITS INDIVIDUAL ORGANS IN BONE TUMORS. Dobrova, G. S.; Gabuniya, R. I.; Kaplan, M. A.; Vedzizhev, G. M. (Inst. of Medical Radiology, Moscow). Med. Radiol.; 17: No. 4, 18-21(Apr 1972). (In Russian).

Studies of the ^{51}Cr labeled human serum albumin metabolism in bone tumors, effected using a 4-detector gamma-spectrometer in a low-background chamber, were summarized. The results showed that in malignant new growths of the bones, elimination of the ^{51}Cr-labeled albumin from the body was delayed as compared to that recorded in normal conditions and in cases of benign tumors, this being due to an elevated amassment of the preparation in the neoplastic tissue. The degree of the ^{51}Cr-labeled albumin retention in the tumor tissue varied depending upon its morphological type, whereas the values of the albumin evacuation from the organism closely approached one another, irrespective of the type of the tumor. In osteogenic sarcoma, radiation therapy did not produce a markedly reduced accumulation of the preparation in the tumor, while in reticular and Ewing's sarcomas there could be observed a significantly diminished access of the ^{51}Cr-labeled albumin to the neoplastic tissue. (auth)

41138 RADIATION MYELOPATHY. Palmer, Jacques J. (Univ. of Washington, Seattle). Brain; 95: Pt. 1, 109-22(1972).

Twelve autopsied cases are presented in which the spinal cord was at risk after radiation treatment (^{60}Co and 2 MeV) of various malignant tumours. Seven developed progressive radiation myelopathy, while five had no radiation-related neurological symptoms at the time of death. The earliest complaints were sensory aberrations progressing to motor weakness and the loss of sphincter control in all but one case. In every instance where necrosis of cord parenchyma was found, there were associated occluded or necrotic blood vessels. Early pathological changes were noted in two patients without clinical evidence of myelopathy. They had had large doses of radiation but their short survival time might not have permitted maturation of the lesion. The data support the lower radiation safety limits established by Pallis et al. (1961). The incidence of radiation myelopathy based on the reported cases in the literature has been estimated at 2.5%. The various proposed causes of radiation myelopathy are discussed but the true cause still remains unresolved. This study favours a vascular cause. (auth) (UK)

41139 LYMPHOPENIA AND CHANGE IN DISTRIBUTION OF HUMAN B AND T LYMPHOCYTES IN PERIPHERAL BLOOD INDUCED BY IRRADIATION FOR MAMMARY CARCINOMA. Stjernswaerd, J.; Vanky, F.; Jondal, M.; Wigzell, H.; Sealy, R. (Karolinska Institutet, Stockholm. Groote Schuur Hospital, Cape Town). Lancet; 1: No. 7765, 1352-6(24 Jun 1972).

A study was made of the relative proportion of bone-marrow (B) and thymus (T) dependent lymphocytes in peripheral blood in patients who had undergone irradiation for mammary carcinoma. One surface marker characteristic for B lymphocytes (receptors for activated complement, EAC) and spontaneous rosette-forming capacity for sheep red blood-cells (E), a property of human T lymphocytes, were investigated in peripheral-blood lymphocytes up to 1 yr after radiotherapy. The ability of lymphocytes to respond to the stimulus of phytohaemagglutinin (P.H.A.) was also tested before and after irradiation was given in vivo. Thirty-four patients were followed up by blood differentials over 1 yr and the frequency of B and T cells analyzed. A statistically significant lymphopenia was found 1 yr after unilateral parasternal irradiation. Healthy controls had a mean of 32% EAC-binding lymphocytes (B cells) and 60% E-binding lymphocytes (T cells). After irradiation there was a statistically significant shift in the proportion of EAC and E binding lymphocytes, with a decrease of T lymphocytes to 45% and a relative increase of B cells to 52%. The ability of lymphocytes to transform after in-vitro stimulation with P.H.A. was decreased in fifteen of nineteen patients tested. It is suggested that irradiation for mammary carcinoma leads to a long-lasting lymphopenia which mainly is a selective T-lymphocyte lymphopenia that may be relevant for the development of distant metastases. (auth) (UK)

41140 APPLICATION OF RADIOSENSITIZING SUBSTANCES IN RADIOTHERAPY. Franke, H. D. (Univ., Hamburg). Strahlentherapie; 143: No. 3, 296-317(Mar 1972). (In German).

A review is presented on the use of sensitizing substances to increase the effectiveness of x radiation for therapy of tumors. Effects of hyperbaric oxygen and fast neutrons on hypoxic tumor cells are discussed and the clinical use of substances that influence DNA metabolism is reviewed. The effects of radiation on tumor cells synchronized by 5-fluorouracil are discussed. (H.L.W.)

41141 STUDIES OF THE MORTALITY OF A-BOMB SURVIVORS. 5. RADIATION DOSE AND MORTALITY, 1950-70. Jablon, Seymour; Kato, Hiroo. Contract AT(49-1)-GEN-72. Radiat. Res.; 50: No. 3, 649-98(Jun 1972).

During 1950 to 1970 mortality from disease, especially from leukemia and other cancer, was high among survivors with large radiation doses. There were minor variations in mortality from causes other than neoplasms but little evidence of radiation effect. Despite observed differences, variation in relative risk among the cancers cannot be stated with certainty because of sampling variability. Survivors who were children under ten when irradiated had the highest relative risks for cancer. Radiation effects decreased with increasing age at the time of the bombs. The data are too sparse to support exact statements as to the shape of the dose-response curves for leukemogenesis or carcinogenesis, but are consistent with linear relationships. Leukemia rates in the high dose groups declined persistently with time but had not yet reached normal levels by 1965 to 1970. The rates for other cancers, however, increased during the study period. (auth)

41142 EFFECTS OF X-RADIATION ON ENAMEL SOLUBILITY. Wiemann, M. R. Jr.; Davis, M. K.; Besic, F. C. (Univ. of Chicago). J. Dent. Res.; 51: No. 3, 868(1972).

An investigation was undertaken to determine if radiation, as commonly experienced during radiation therapy, influences solubility or affects the structure or chemistry of teeth, or does both. Portions of teeth exposed to radiation were compared with portions from the same teeth that received no radiation. There appeared to be no significant difference in the depth of decalcification between the experimental and control groups. Determination of the rate of demineralization by means of measuring the depth of penetration of the decalcified zone indicate that x-radiation exposure of extracted tooth specimens does not affect enamel solubility to a substantial degree. A dispersion staining device was used to determine whether tooth structure or chemistry had been altered or influenced in any way by the radiation procedures. It was concluded that apparently no chemical or structural changes took place in the specimens subjected to the x radiation treatment. (C.H.)

Vertebrates

Refer also to abstracts 41028–41032 and 41309.

41143 (AEC-tr-7307) RADIOBIOLOGY. Translation of Radiobiologiya; 11: No. 6, 811-960(1971). 176p. Dep. NTIS.

Separate abstracts were prepared for each of the 27 papers appearing in this cover-to-cover translation. (E.R.B.)

For abstracts of individual papers see: 41028–41032, 41049, 41050, 41144–41160, and 41217–41219.

41144 (AEC-tr-7307, pp 1-17) BIOCHEMICAL BACKGROUND OF RADIORESISTANCE. Goncharenko, E. N. (Moscow State Univ.). Translated from Radiobiologiya; 11: No. 6, 811-24(1971).

This article is devoted to the biochemical background of increased radioresistance. It is noted that recently much attention has been devoted to the indirect nature of the protective effect of radioprotectors. Without denying the importance of existing hypotheses concerning the reasons for creation of a biochemical background as a result of the administration of radioprotectors, the author sets forth and experimentally supports the idea that the biochemical background of increased radioresistance is determined by a combination of biochemical changes which includes not only the already known biochemical changes, but also an increase in the content of endogenous substances having a radioprophylactic effect (serotonin, dopa amine, histamine) and a decrease in the level body of radiosensitizers (in particular, the products of oxidation of unsaturated fatty acids). The author discusses approaches for further work on the problem of creating a background of increased radioresistance under the influence of radioprotectors introduced into the body. (tr-auth)

41145 (AEC-tr-7307, pp 30-6) CYTOGENETIC EFFECT OF ACCELERATED CARBON AND BORON IONS ON THE CORNEAL EPITHELIAL CELLS IN MICE. Grigor'ev, Yu. G.; Ryzhov, N. I.; Vorozhtsova, S. V.; Koshcheeva, L. A.; Popov, V. I.; Kudryashov, E. I. Translated from Radiobiologiya; 11: No. 6, 835-40(1971).

A comparative study was made of the mitotic index and frequency of aberrant mitoses in the corneal epithelial cells of mice irradiated at 180 kV by x rays and accelerated carbon and boron ions. The authors demonstrate a distinct dependence of the yield of observed effects on dose. In the dose range from 25 to 500 rad the dependence has an exponential nature. The coefficients of the general biological effect of boron and carbon ions were established for 180-kV x radiation. A study of the frequency of aberrant mitoses gave values 4.65 ± 0.02 and 4.35 ± 0.02, respectively. (tr-auth)

41146 (AEC-tr-7307, pp 37-43) MECHANISMS OF POSTRADIATION DEVASTATION OF RADIOSENSITIVE TISSUES DETERMINED FROM DNA METABOLISM INDICES. Tereshchenko, O. Ya. (Biophysics Inst., Moscow). Translated from Radiobiologiya; 11: No. 6, 841-5(1971).

The intensity of DNA synthesis and decay was determined in the tissues and these indices were used in judging the intensity of reproduction and radiative destruction of cells in radiosensitive tissues of irradiated rats. It is shown that in the early postradiation devastation of radiosensitive tissues the interphase destruction of cells plays a more important role than the suppression of cell reproduction. (tr-auth)

41147 (AEC-tr-7307, pp 58-67) MOLECULAR MECHANISM OF CELL DAMAGE AND PROTECTION AGAINST EXPOSURE TO IONIZING RADIATION. BASIC CONCEPTS. Eydus, L. Kh. (Inst. of Biological Physics, Pushchino, USSR). Translated from Radiobiologiya; 11: No. 6, 857-64(1971).

The concept that cell protection against exposure to radiation by different chemical and physical agents can be explained by a single molecular mechanism is discussed. The basis for this concept is that there is latent radiation damage to macromolecules and an adsorption mechanism of the action of low-molecular substances. The author proposes the hypothesis of a molecular mechanism of the inhibiting influence of radiation on the cell, based on these same concepts of the role of the adsorption mechanism of interaction between macromolecules and low-molecular compounds. (tr-auth)

41148 (AEC-tr-7307, pp 82-7) INTENSIFYING THE BIOLOGICAL EFFECT OF IONIZING RADIATIONS. COMMUNICATION 5. EARLY POSTRADIATION PROTECTION OF MICE BY LYMPH NODE CELLS OF SYNGENIC DONORS IRRADIATED IN A DOSE OF 25 RAD. Svet-Moldavskaya, I. A.; Yarmonenko, S. P.; Red'kina, E. K.; Dzerzhinskaya, I. I.; Osipova, T. V. (Second Moscow Medical Inst., Moscow. Inst. of Experimental and Clinical Oncology, Moscow). Translated from Radiobiologiya; 11: No. 6, 875-9(1971).

It is shown that lymph node cells of hybrid mice (CBAxC_{57}Bl/6) taken 2 to 5 days after total gamma radiation in a dose of 25 rad protect the syngeneic recipients irradiated in a lethal dose. According to mean data from eight experiments, 57% of the protected animals survived, whereas in the control the survival rate was 14%. The number of colonies in the spleens of recipients receiving irradiated lymph nodes does not differ from that observed in the control mice. The morphological changes in the lymph nodes of donors irradiated in a dose of 25 rad are expressed in an increase in the number of small lymphocytes and cell elements of the plasmocytic series. (tr-auth)

41149 (AEC-tr-7307, pp 88-93) EFFECT OF SOME MODIFYING AGENTS ON THE FORMATION OF RADIORESISTANCE IN THE BODY DURING GAMMA IRRADIATION. Ayrapetyan, G. M.; Ayzina, N. L.; Ovakimov, V. G.; Ivanov, V. N. Translated from Radiobiologiya; 11: No. 6, 880-3(1971).

Experiments on mice exposed to general one-time gamma irradiation with an intensity of 710 R/min revealed an approximately identical level of radioprotective effect when the body was first exposed to some stress factors and with the introduction of mexamine. A hypothesis on the mechanism of formation of body radioresistance is proposed. (tr-auth)

41150 (AEC-tr-7307, pp 94-9) PERIPHERAL BLOOD REACTION IN ANIMALS AS A FUNCTION OF RADIATION CONDITIONS. Moskalev, Yu. I.; Petrovich, I. K.; Grammatikati, V. S.; Reytarovskiy, I. K. (Biophysics Inst., Moscow). Translated from Radiobiologiya; 11: No. 6, 884-8(1971).

In experiments on white rats a study was made of the effect of x and beta radiations on the composition of the peripheral blood during irradiation of the entire body and its front and rear halves. According to the reaction of lymphocytes, the total beta irradiation was 23 times less effective, irradiation of the front half of the body was 12 times less effective, and irradiation of the rear half of the body was 7 times less effective than the corresponding x radiation. (tr-auth)

41151 (AEC-tr-7307, pp 100-8) NERVOUS SYSTEM RADIOSENSITIVITY. Badmindra, V. P.; Mayorova, N. F. (Leningrad State Univ. Central Scientific Research Inst. of Roentgenology and Radiology, Leningrad). Translated from Radiobiologiya; 11: No. 6, 889-96(1971).

Light and electron microscopy methods were used in studying the posttraumatic regeneration of synapses in the superior cervical node in cats after bilateral cutting of the sympathetic trunk and subsequent total irradiation of animals in doses of 30, 100, and 500 R. Restoration of the synapses was accelerated by 20% after exposure to small doses (30 R), slightly delayed after irradiation in intermediate doses (100 R), and sharply inhibited in a series of experiments with irradiation of 500 R. (tr-auth)

41152 (AEC-tr-7307, pp 119-22) METHOD FOR COMPUTING THE QUANTITATIVE CHARACTERISTICS OF THE POSTRADIATION RECOVERY PROCESS. Grigor'ev, Yu. G.; Gorlov, V. G.; Popov, V. I.; Repin, N. N.; Tabakova, L. A.; Farber, Yu. V.; Yurgov, V. V. Translated from Radiobiologiya; 11: No. 6, 903-6(1971).

A model description of the postradiation recovery process that makes it possible to determine the recovery parameters after acute irradiation on the basis of an estimate of the number of leukocytes in the peripheral blood and the absolute number of bone marrow cells containing nuclei is presented. The proposed method can be used for computing the quantitative characteristics of the process of postradiation recovery of the blood-forming system for the cases of minimum lethal and close to mean lethal irradiation doses. (tr-auth)

41153 (AEC-tr-7307, pp 123-7) SPINAL CORD PHOSPHOPROTEINS IN ANIMALS WITH RADIATION DAMAGE. Sokolov, I. I. (Dnepropetrovsk State Univ., USSR). Translated from Radiobiologiya; 11: No. 6, 906-9(1971).

A study was made of the effect of x radiation (1200 R) on the content and metabolism of phosphoproteins in the lumbar enlargement of the spinal cord in cats. There was a decrease in the content of phosphoproteins on the 2d and 6th to 7th days after irradiation (by 19.5 and 48.7%, respectively). Against a background of a decrease in the content of spinal cord phosphoproteins, the metabolic indices (specific activity, relative specific activity, relative activity) increase reliably on the 2d day after irradiation. On the 6th to 7th days the metabolic indices differ: relative specific activity increases, relative activity decreases, and specific activity does not change. (tr-auth)

41154 (AEC-tr-7307, pp 128-32) CHARACTERISTICS OF THE COURSE OF LEUKOCYTIC REACTIONS IN MONKEYS DURING CHRONIC LOW-DOSE IRRADIATION. Dzhikidze, E. K.; Kuksova, M. I. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Translated from Radiobiologiya; 11: No. 6, 909-12(1971).

A study was made of reactivity in the blood-forming system by applying the method of inducing leukocytic reactions over a 4-hour period with milk (10%), cortisone acetate (20 mg in the form of a suspension), ACTH (10 units), and under experimental conditions in 22 rhesus monkeys subjected to multiple irradiation in doses of 4.35 and 1.37 R/day to total doses of 803, 930, 1490, and 1561 R. There were deviations from the normal course of leukocytic reactions (absence or weak degree of expression of the reaction to hormonal preparations and the experimental conditions); these had but a slight dependence on the total radiation dose. (tr-auth)

41155 (AEC-tr-7307, pp 133-7) PROTECTIVE EFFECT OF MEXAMINE AND SEROTONIN ON THE COURSE OF PREGNANCY IN WHITE RATS DURING X IRRADIATION. Stanzhevskaya, T. I. (Central Scientific Research Inst. of Roentgenology and Radiology, Leningrad). Translated from Radiobiologiya; 11: No. 6, 913-16(1971).

The radioprotective drugs mexamine and serotonin were injected intraperitoneally in common female white rats on the 4th, 11th, and 13th days of pregnancy without irradiation and 20 minutes prior to irradiation in a dose of 200 rad. Both drugs were teratogenic when used on the 11th day of pregnancy. Mexamine and serotonin simultaneously decreased the teratogenic and lethal effect of irradiation; serotonin was more effective with respect to the index of decreasing the number of anomalies in eye development in embryos (from 100 to 30.4%) when injected on the 11th day. (tr-auth)

41156 (AEC-tr-7307, pp 138-43) ROD APPARATUS PARTICIPATION IN THE RETINAL REACTION TO THE EXCITING EFFECT OF IONIZING RADIATION. Kalmykova, G. I.; Sverdlov, A. G. (Physical-Technical Inst., Leningrad). Translated from Radiobiologiya; 11: No. 6, 916-20(1971).

The bioelectric reaction was used in studying the change in retinal sensitivity of a frog to exposure to x rays, red, and blue light, in the process of adaptation to the darkness. An identity of the changes in sensitivity to blue light and x radiation was noted. A study was also made of the critical frequency of merging of the reaction (CEMR) to discontinuous-stimulation by ionizing radiation. It was established that the retinal reaction to this exposure is characterized by a low lability. These results can indicate that with the used doses of x radiation in the frog's retina (mixed retinal structure), the bioelectric reaction to radiation is associated with the rod apparatus. (tr-auth)

41157 (AEC-tr-7307, pp 144-8) CHANGE IN THE HALF-LIFE OF ERYTHROCYTES ACCOMPANYING DAILY FRACTIONAL IRRADIATION OF RATS. Voronin, V. S. (Biophysics Inst., Moscow). Translated from Radiobiologiya; 11: No. 6, 920-3(1971).

A study was made of the half-life $T_{1/2}$ of erythrocytes during prolonged fractional irradiation of rats of the Wistar line (50 R per day). During the irradiation process there was a well-expressed shortening of $T_{1/2}$ for the red blood cells. There was a distinct dependence between shortening of the lifetime of erythrocytes and the decrease in their number in the blood channel. (tr-auth)

41158 (AEC-tr-7307, pp 149-52) EFFECT OF MEXAMINE AND CYSTAPHOS ON ENTEROCHROMAFFIN CELLS IN INTACT AND IRRADIATED RATS. Pankratova, G. G.; Chernov, G. A. (Biophysics Inst., Moscow). Translated from Radiobiologiya; 11: No. 6, 923-6(1971).

Mexamine and cystaphos in radioprotective doses exerted no influence on the enterochromaffin cells in intact animals. The prophylactic use of mexamine exerted a normalizing effect during the height of the disease and cystaphos exerted a corresponding effect during the recovery period. (tr-auth)

41159 (AEC-tr-7307, pp 153-8) ADRENOCORTICOTROPIC FUNCTION OF THE HYPOPHYSIS DURING IRRADIATION. Romashko, O. O. (Biophysics Inst., Moscow). Translated from Radiobiologiya; 11: No. 6, 926-30(1971).

A study was made of the adrenocorticotropic function of the hypophysis in rats during irradiation in doses of 650, 850, and 1000 R. It was shown that ionizing radiation causes a biphase reaction in activation of the adrenocorticotropic activity appearing during the first hours after exposure. In addition, there was also a late reaction in the activation of the ACT function occurring 3 or 4 days after irradiation. It was noted that the dynamics of change in adrenocorticotropic activity during irradiation differs from that caused by other stress agents. (tr-auth)

41160 (AEC-tr-7307, pp 159-65) CHANGE IN RADIORESISTANCE OF SOME SPECIES OF SALMON IN THE EARLY STAGES OF EMBRYONAL DEVELOPMENT. Gorodilov, Yu. N. (Leningrad State Univ.). Translated from Radiobiologiya; 11: No. 6, 930-4(1971).

A study was made of the radiosensitivity of three species of salmon: Salmo salar, S. irideus, and Coregonus peled at early stages in embryonal development (segmentation, blastula, gastrula, early organogenesis). The degree of radioresistance of different stages was judged at the end of the embryonal period from the number of emerging larvae. The following picture, described in the literature, was confirmed for all three species: the radioresistance level for embryos increases in the development process. The mechanisms of an increase in radiotolerance during the process of early ontogenesis are discussed. (tr-auth)

41161 (CONF-710201, pp 130-48) BETA-PARTICLE DOSE RATES IN HUMAN AND ANIMAL BONE. Spiers, F. W. (Univ. of Leeds, Eng.); Zanelli, G. D.; Darley, P. J.; Whitwell, Joan R.; Goldman, Marvin. Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

Recent progress in the identification and location of tissues at risk in irradiated bone has shown that the most useful doses to consider are the mean absorbed dose to the hematopoietic marrow in trabecular bone, the mean absorbed dose averaged over a distance 0 to 10 μm from the trabecular surfaces, and the mean absorbed dose averaged over 0 to 10 μm from the endosteal surfaces in cortical bone. Monte Carlo methods were used to calculate dose rates 1 and 2 from various uniformly distributed beta emitters for seven specimens of human bone. The results show that trabecular structure is of great importance in determining the dose rates to the cells at risk. Experimental measurements of mean dose rates in the marrow spaces, as in category 1, were carried out by using thermoluminescent dosimetry in five bones of beagle dogs following uptake of ^{90}Sr-^{90}Y. The dose rates varied considerably between bones and in different parts of the same bone. In this case, too, the structure of the bone was of critical importance. In view of the part played by the trabecular structure, an automatic scanning microscope was used to obtain path-length distribution across trabeculae and marrow spaces for several human and animal bones. Although the mean path length across the trabeculae did not vary greatly between animal and human bones, that across the marrow cavities varied by factors of 3 or 4. The implications of the results are discussed with reference to dose rates to the cells at risk in human trabecular bone and the application of the results of experiments in animals to the human case. (auth)

41162 (COO-1156-43) INTRASPECIFIC COMPETITION AND RESPONSE OF PIKAS (OCHOTONA PRINCEPS) TO RADIATION. Markham, O. D.; Whicker, F. W. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). [1970]. Contract AT(11-1)-1156. 21p. (CONF-710501-54). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

This study was designed to demonstrate the effect of social interaction upon the response of pikas (Ochotona princeps) to 500 R ^{60}Co irradiation delivered acutely. Two one-acre enclosures were stocked with 15 and 31 pikas and another group of experimental animals was held captive in individual cages. One experiment was begun in August, 1969, and another was conducted in October of the following year. Results indicated that animals confined individually had a significantly higher survival rate and longer survival time than animals free to interact in each of the two enclosures. These results substantiate findings of a previous experiment in which pikas studied in the natural environment at 4055 meters elevation on Mount Evans, Colorado had a lower $LD50_{(30)}$ and shorter survival times than individually-caged animals in captivity. Animals in the 15 cage enclosure appeared to have a lower survival rate than animals in the 31 cage area. This difference may be explained by the greater number of dens and rock piles available per pika in the 31 cage area which resulted from a greater number of deaths caused by territorial battles prior to the irradiation treatment. (auth)

41163 (COO-1602-32) EFFECTS OF X-IRRADIATION ON STEROID BIOTRANSFORMATIONS BY TESTICULAR TISSUE. Technical Progress Report. Ellis, LeGrande C. (Utah State Univ., Logan. Dept. of Zoology). [1972]. Contract AT(11-1)-1602. 7p. Dep. NTIS.

Two systems, the pineal gland and serotonin, were found to affect testicular function and androgen biosynthesis in rats through a mediated response involving the formation of H_2O_2. Also, direct effects of x irradiation on catalase activity, H_2O_2 production, lipid peroxidation, and monoamine oxidase activity in the testes were observed. Endogenous melatonin and serotonin are deleterious to the testes, however, when administered before irradiation they provided a radioprotective effect. When administered after irradiation, they were harmful. It is now possible to explain radiation effects on the testes on a biochemical basis. The biochemical changes correlate well with the pathological changes. (E.R.B.)

41164 (COO-1602-33) EFFECTS OF X-IRRADIATION ON STEROID BIOTRANSFORMATIONS BY TESTICULAR TISSUE. (Utah State Univ., Logan). [1972]. Contract AT(11-1)-1602. 9p. Dep. NTIS.

A comprehensive report is presented of the research and administrative activities associated with the contract. The main research accomplishments with respect to original stated objectives are briefly summarized. The research centers around the roles of melatonin and serotonin in the biochemical mechanisms underlying testicular function, and their roles in the effects of x irradiation on testicular function. Plans for continued research on the present objectives are stated, and new objectives are introduced. Graduate training activities are listed as are publications associated with the contract. Federal support of the research project is listed and the relevance of the study to modern day problems is discussed. (E.R.B.)

41165 (COO-3013-2) RADIATION EFFECTS ON CELLULAR PROLIFERATION AND DIFFERENTIATION IN THYMUS LYMPHOCYTES. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore, Md. Dept. of Radiological Sciences). 8 Aug 1969. Contract AT(30-1)-3970. 14p. Dep. NTIS.

A review is presented of radiation effects on cellular proliferation and differentiation during lymphopoiesis in the thymus. Some topics discussed are: kinetics of the cell cycle and cell proliferation using tritiated thymidine and high resolution autoradiography; response of hematopoietic tissues of mice to continuous low dose irradiation; radiation effects on distribution of cell types and histology of the thymus cortex; radiation effects on the curve of percentage labeled mitoses in mice; radiation effects on proliferation rate in lymphocyte cell compartments; radiation effects on numbers of PAS-positive reticulum cells in thymus cortex; radiation effects on renewal and loss of small lymphocytes; regulatory feedback mechanisms for control of population size and compensatory cell proliferation; radiation effects on lymphoid cell populations in thymus; and homeostatic mechanisms involved in achieving a balance between cell population size, the rate of cell transfer from proliferating to nonproliferating compartments, and the rate of cell loss. (H.L.W.)

41166 (COO-3013-5) THYMUS CELL POPULATION STUDIES DURING RADIATION LEUKEMOGENESIS. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore, Md. Dept. of Radiological Sciences). [1969]. Contract AT(11-1)-3013. 6p. (CONF-690568-1). Dep. NTIS.

From seventeenth annual meeting of the Association of University Radiologists; San Francisco, CA. (8 May 1969).

Cellular control mechanisms concerned with cell proliferation and division and thus population level regulation influence the degree and rate of cell turnover and the initiation of cell differentiation. Certain important relationships involving the regulation of cell reproduction and differentiation obtain between the kinetics of normal cell renewal and tumor cell systems, and these may provide information on cellular mechanisms of neoplastic transformation. Both cell systems may have variable rates of cell birth, are self-maintaining, and are primarily proliferative. The maintenance of cell number does not necessarily depend on a stem cell population, and only a fraction of the cells may be in the proliferative compartment. The balance between cell population size, the rate of transfer from proliferating to nonproliferating compartment, and the rate of cell loss, for example, for differentiation, are profoundly disturbed in neoplastic growth. The following studies to be reported concern quantitative autoradiographic investigations of DNA synthesis and the cell cycle during radiation leukemogenesis in mice and are aimed at providing information on (1) lymphoid cell and tissue kinetics during the development of radiation-induced thymic lymphoma, and (2) regulatory control mechanisms and changes in the patterns of cell population kinetics leading to uncontrolled growth, and frequently a loss of morphological or functional evidence of differentiation. Four week old C57BL/6J male mice, weighing approximately 10 grams at the beginning of the experiments, were used. Mice were given 800 rads of whole-body x radiation in four fractions (200 rads at weekly intervals for 4 weeks) according to the method of Kaplan. Each week for 25 weeks following the first irradiation, pairs of mice were injected intraperitoneally with tritiated thymidine, approximately 1.0 μCi/gram body weight, and killed 1 hr later. A control group of unirradiated mice was treated similarly. (auth)

41167 (COO-3013-33) CELL CYCLE AND GROWTH KINETICS DURING RADIATION LEUKEMOGENESIS IN C57BL MICE. Fabrikant, Jacob I.; Foster, Bessie R. (Connecticut Univ., Farmington. Dept. of Radiology). 1971. Contract AT(11-1)-3013. 4p. (CONF-711114-1). Dep. NTIS.

From Meeting on NDT for reactor core components and pressure vessels; Vienna, Austria (29 Nov 1971).

Mice were whole-body irradiated four times at intervals of seven days and changes in the mean weight of the thymus were recorded; at 25 weeks after the first irradiation the irradiated thymuses were three times larger than those of control mice. At this time disseminated leukemia developed in more than half of the irradiated mice. The median durations of the lymphoid cell cycle and its phases were determined during development of lymphoma and disseminated leukemia by the method of percentage labeled mitoses. In view of increased duration of DNA synthesis and changes in the cell cycle it appeared that thymic leukemogenesis was associated with progressive breakdown of cellular control mechanisms involved in the regulation of cell reproduction. During leukemogenesis, changes in the control of cell growth and division occurred not only in the proliferative cell compartment, but in the differentiation and functional cell compartments, and probably in the stem cell compartment as well, thereby profoundly disturbing the rates of cell flux and transition from one compartment to another. (H.L.W.)

41168 (COO-3013-46) SPERMATOGONIAL CELL RENEWAL UNDER LOW LEVEL IRRADIATION. VII. CELLULAR DEPOPULATION UNDER 45 RADS PER DAY. Hsu, Thomas H. S.; Fabrikant, Jacob I. (Connecticut Univ., Farmington. Dept. of Radiology). [nd]. Contract AT(11-1)-3013. 6p. (CONF-720530-1). Dep. NTIS.

From twentieth annual meeting of the Radiation Research Society; Portland, OR. (14 May 1972).

The present study concerns cellular response and cell population kinetics in the seminiferous epithelium of the C57BL mouse under continuous irradiation at 45 rads per day. At this dose rate, C57BL mice could live for prolonged periods and have been used in previous studies on the effects of prior continuous irradiation on hematopoietic cell proliferation. These investigations examine the extent to which proliferating cells in the premeiotic stages of spermatogenesis can accumulate cellular nonlethal radiation damage affecting the regenerative capacity of spermatogonial cell renewal. The experiments include a detailed analysis of changes in the cell population structure and cell cycle kinetics during radiation depopulation using the techniques of quantitative histology and high resolution autoradiography combined with incorporation of the labeled DNA precursor, tritiated thymidine. (auth)

41169 (COO-3013-47) LYMPHOID CELL RENEWAL UNDER LOW-LEVEL IRRADIATION. XII. REGULATION OF THYMUS CELL PROLIFERATION UNDER CONTINUOUS EXPOSURE. Fabrikant, Jacob I. (Connecticut Univ., Farmington. Dept. of Radiology). 1972. Contract AT(11-1)-3013. 6p. (CONF-720530-3). Dep. NTIS.

From twentieth annual meeting of the Radiation Research Society; Portland, OR. (14 May 1972).

Cellular response and cell population kinetics during lymphopoiesis in the thymus of C57 black mice under continuous γ irradiation at 45 rads per day were studied. From data on pulse-labeling, repeated labeling, percentage labeled mitoses, and grain count decrements, it appears that under continuous irradiation there was an increased proliferation rate in all lymphocyte cell compartments, little or no change in the median cell cycle times, but a decrease in the spread of cell cycle times, primarily through a reduction in $G_1 + M/2$ complex. The half-time of renewal for the small lymphocyte population was decreased under continuous irradiation from approximately

36 to 30 hrs due to an increased cell production rate from approximately 1.4 to 1.7% per hr. (E.R.B.)

41170 (COO-3269-1) ALTERATION OF TASTE THRESHOLDS BY LOW DOSES OF IONIZING IRRADIATION. Eighth Year Progress Report, May 1, 1971–May 1, 1972. Shaber, Gary S. (Thomas Jefferson Univ., Philadelphia, Pa. (USA). Dept. of Radiology). 1972. Contract AT(11-1)-3269. 7p. Dep. NTIS.

In experiments on the effects of low dose x irradiation on the taste threshold of rats, the following results are reported for the current contract period: the subcutaneous administration of nickel acetate appeared to lower the taste threshold for quinine hydrochloride in normal rats; when administered subcutaneously before and after x irradiation of the tongue at a dose of 50 rads, nickel acetate appeared to have a protective effect. (E.R.B.)

41171 (COO-3380-1) TUMORIGENIC ACTION OF BETA, PROTON, ALPHA, AND ELECTRON RADIATION ON THE RAT SKIN. Progress Report, August 1, 1971–July 31, 1972. Albert, Roy E. (New York Univ., N. Y. Dept. of Environmental Medicine). Contract AT(11-1)-3380. 20p. Dep. NTIS.

Progress is reported on the following research projects: effects of protons in a sieve pattern on skin tumor incidence in rats; comparative resistance of mouse and rat skin to tumor induction by electrons; effects of dose fractionation on tumor incidence and hair follicle atrophy in rat skin; induction of tumors during the phase of hair growth; tumor induction in a resistant strain of rats; kinetics of recovery from carcinogenic damage; critical depth for tumor induction during the growing phase; dose-response curve for growing phase at 1 mm penetration; effect of postirradiation proliferative stimuli on tumor incidence; effect of a sieve pattern in tumor induction for low-energy x rays; cell death and regeneration in the hair follicles and surface epidermis; properties of the G_0 phase in rat epidermis; and treatment of radioinduced skin tumors with methotrexate. (H.L.W.)

41172 INTERACTIONS OF TOTAL DOSE AND DOSE RATE IN DETERMINING TISSUE RESPONSES TO IONIZING RADIATIONS. Norris, William P.; Fritz, Thomas E. (Argonne National Lab., Ill.). pp 243-60 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

Young adult beagle dogs of both sexes are being whole-body exposed continuously to ^{60}Co γ rays at exposure rates ranging from 5 to 300 R/22 hour exposure day. The study has progressed to 1020 days of exposure. Three primary causes of death, septicemia, anemia, or myeloproliferative disease (MPD), have been identified and related to exposure rate. At 35 R/day and above, all dogs died with septicemias associated with granulocytopenia. All three causes of death occurred among dogs given 17 R/day, with septicemic deaths preceding deaths from anemia, and death from MPD occurring even later. At either 5 or 10 R/day there were no deaths due to septicemia, and deaths from anemia always occurred earlier than deaths from MPD. The lowest exposure rate that produces septicemic death in the beagle is about 17 R/day, while the threshold exposure rate for anemic death is about 5 R/day. The minimum total exposure necessary to produce any of the three types of death seems to be about 2000 R. The authors attempt to demonstrate the relevance of these findings to the interpretation of radiation-induced effects from radionuclides deposited within the mammalian body. (auth)

41173 EFFECTS OF FAST NEUTRON IRRADIATION ON THE ENZYME CONTENT OF THE RAT BRAIN. Wykoff, M. H. (Univ. of Tennessee, Oak Ridge). Health Phys.; 23: No. 1, 115-16(Jul 1972).

It is stated that increased β-glucuronidase and acid and alkaline phosphatases have been observed in the cerebrospinal fluid of burros exposed to fast neutron irradiation, and since these enzymes are considered to be contained in the lysosomes it was decided to investigate whether the lysosome concept could be applied to the brain, and also to examine relationship of the observed histopathological changes to lysosomal destruction brought about by exposure to ionizing radiation. Experimental details are given. Irradiation was with the Health Physics Research Reactor at ORNL, and the rats were exposed unilaterally to a midline fast neutron dose of 700 rads at 40 rads/min. Free and total enzyme contents of the brain were determined, and the results are discussed. It was concluded that the irradiation did not damage the lysosomes in the brain-cells, since the total β-glucuronidase value was uniformly higher than the free value. The irradiation also appeared to have little effect on the overall β-glucuronidase content of the brain. It is considered that in order to assess irradiation damage to brain cells by enzyme assay a better knowledge of the enzyme content of the lysosomes in the brains of given species and the influence of these enzymes, when freed, on brain function and metabolism is required. (UK)

41174 EFFECTS OF X IRRADIATION ON THE MITOTIC ACTIVITY OF THE SUBEPENDYMAL PLATE OF RATS. Hopewell, J. W.; Cavanagh, J. B. (Saint Mary's Hospital Medical School, London). Brit. J. Radiol.; 45: No. 534, 461-65(Jun 1972).

The brains of groups of young adult rats were irradiated with exposures of 200, 800, 2,000, and 4,000 R (220 kV x rays). At various times after irradiation animals were killed and the mitotic activity in the subependymal plate cells about the lateral ventricles was determined. The mitotic activity of this layer slowly returned to normal with exposures of 2,000 R and less, but not following an exposure of 4,000 R. The relevance of this to the phenomenon of delayed cerebral white matter necrosis is discussed in terms of the impairment of cell renewal systems by irradiation. (UK)

41175 SOME EFFECTS OF X-IRRADIATION ON THE ACTIVITY OF THE THYROID AND PITUITARY GLANDS OF XENOPUS LAEVIS (AMPHIBIA) DURING METAMORPHOSIS. Chopra, D. P. (Royal Victoria Infirmary, Newcastle-upon-Tyne, Eng.; Hamilton, Louie. J. Zool.; 166: Pt. 2, 159-62(Feb 1972).

Xenopus larvae received 2500 rads of whole-body x-rays. Nine hours after irradiation both pituitary and thyroid volumes were significantly less than the controls. From 24 hours after, the volumes had returned to control levels. The mitotic incidence in irradiated thyroids fell within five hours to one tenth of the control value and remained suppressed for at least three days. (auth)

41176 GLYCOGEN METABOLISM OF PLACENTA AND LIVER OF MICE BEFORE AND AFTER WHOLE-BODY X-IRRADIATION. Tarachand, U.; Eapen, Jacob (Bhabha Atomic Research Centre, Bombay). Indian J. Exp. Biol.; 9: No. 3, 312-13 (Jul 1971).

Glycogen metabolism of normal and x-irradiated, non-pregnant and pregnant (12th to 18th day of gestation) mice has been studied. The results show that hepatic glycogen levels of non-irradiated mice are rather steady throughout pregnancy, placental glycogen is highest on 16th day of gestation and foetal liver glycogen increases at a consistently fast rate during gestation. Liver glycogen levels of non-pregnant and pregnant mice increase 24 hr after x-irradiation whereas placental and foetal glycogen levels diminish. The metabolic differences of liver and placental glycogen are discussed. (auth)

41177 HISTOCHEMICAL STUDIES OF THE PROTEIN-BOUND THIOL AND DISULFIDE GROUPS IN THE RETINA. Khunnoiy, Somboon. Ann Arbor, Mich.; Univ. of Michigan (1971). 200p. University Microfilms Order No. 72-14,911.
Thesis.

In a comparative histochemical and histological survey (Part I) on the retinas of 29 vertebrates and three invertebrate (cephalopod) species, paraffin sections were stained for cysteinyl thiol and disulfide groups as well as for the basic groups on the proteins; routine hematoxylineosin staining, a method for DNA and RNA, and the PAS-glycogen procedure were used for identification and orientation purposes. The adult pattern of protein thiol distribution in the retina was found in a developmental study of the rat and chick (Part II) to appear after histological differentiation and at about the time of functional maturation. This was felt to strengthen the view that the thiol groups of retinal proteins are in general necessary for the special metabolism of the retina. Finally, after noting the histochemical and histopathological changes induced experimentally (Part III) by various agents known to cause degeneration of the photoreceptors, some degree of involvement of protein thiols of the outer segments in the maintenance of the photoreceptor cells was proposed. Very high light levels and sodium iodate injections were thought to act by allowing or causing, respectively, the oxidation of the thiols of the visual pigments, leading by unknown means to photoreceptor breakdown. X irradiation was considered not to act by the same mechanism. (Diss. Abstr. Int., B)

41178 EFFECTS OF ^{60}Co RADIATION AND SOCIAL INTERACTION ON THE PIKA (OCHOTONA PRINCEPS). Markham, Orville Doyle. Fort Collins, Colo.; Colorado State Univ. (1971). 62p. (COO-1156-48). University Microfilms Order No. 72-16,117. Thesis.

Estimates of the $LD50_{(30)}$ from ^{60}Co radiation were made for a group of pikas (Ochotona princeps) held in captivity and for another group observed in the natural environment near the summit of Mount Evans, Colorado. The $LD50_{(30)}$ estimate was 560 R (438-717 R; 95% confidence limits) for captive animals and 380 R (250-578 R) for pikas at Mount Evans. Mean survival times for irradiated pikas were 9 to 13 days in captivity and 5 to 7 days in the natural environment. Results are discussed in relation to artificial stresses resulting from captivity and natural stresses such as intra-specific competition and predation. As a result of the $LD50_{(30)}$ studies, a series of studies were designed to demonstrate the detrimental effect of aggressive social interaction upon the response of pikas to 500 R of Cobalt-60 irradiation. Two one-acre enclosures were shocked with 15 and 31 pikas, and another group of experimental animals was held captive in individual cages. Results indicated that during the late summer and fall animals confined individually had a significantly higher survival rate and longer survival times than animals free to interact in each of the two enclosures. These results substantiate findings of the $LD50_{(30)}$ experiments. However, it appeared that animals irradiated in the spring during the breeding season survived equally in the individual cages and the enclosures. (Diss. Abstr. Int., B)

41179 SOME EFFECTS OF X-RAY AND TRYPAN BLUE ON THE PREIMPLANTATION MOUSE EMBRYO. Fisher, Don Lowell. Minneapolis; Univ. of Minnesota (1971). 193p. University Microfilms Order No. 72-14,293. Thesis.

The effects of x-irradiation and trypan blue were studied on the preimplantation mammalian embryo. To obtain embryos, 3-6 week old female mice of strain 129/SvS1 were superovulated. Forty-eight hours following mating with adult males the females were sacrificed and the 4-6 cell embryos were placed in culture using Brinster's defined medium and culture method. Irradiation effects were studied in vitro and in vivo. Irradiation in culture was direct. To accomplish in vivo irradiation, superovulated females 48 hours after copulation were given whole body irradiation. Embryos were removed within 2 hours and placed in culture. Control embryos for both groups were sham irradiated. The effects of x-ray on development of the embryo to blastocyst were compared between groups. No differences were noted between the control groups. Approximately 80% of the control embryos developed to blastocysts. The LD_{50} (50% of control development level) for blastula development following in vitro irradiation was 300 R. The LD_{50} for blastula development following in vivo irradiation was 600 R. Blastocysts developing after 48 hours of culture for both irradiation groups were transplanted to 2 day pseudopregnant nulliparous adult females of the same strain. Fifteen days following transplantation of apparently viable blastocysts determination of postimplantation effects were made. No differences were noted between control groups. No fetal development occurred for embryos irradiated in vitro with more than 170 R. Fetal development was observed for embryos irradiated in vivo with up to 388 R. Fifteen days following transplantation no indications of implantations were observed for embryos irradiated in vitro with more than 291 R. Trypan blue effects were observed by direct exposure of the embryo to varied concentrations over a 48 hour period. Control embryos were cultured in untreated medium. Trypan blue was found to retard or arrest development of the blastocyst. Approximately 80% of the control embryos developed to blastocyst. The LD_{50} was determined at a concentration of 0.155%. Exposure to trypan blue in vitro for various lengths of time was also examined. Control embryos were cultured and transferred in medium and found to develop at approximately the 80% level. For concentrations at the LD_{50} (0.16%) and the LD_{99} (0.35%), embryonic development to blastocyst did not deviate from control embryonic development unless exposed to the dye for longer than 2½ hours. Blastocysts developing in trypan blue were transplanted similarly to those treated with x-irradiation. Approximately 70% of all implanting control blastocysts developed into fetuses. Fetal development observed 15 days after transplantation was found to be significantly retarded after exposure to a concentration of 0.08% or more for 48 hours. Fetal weights were found to be significantly reduced following treatment by both x-irradiation and trypan blue, but no significant gross or skeletal abnormalities of the preterm fetus were discovered in either group. It would appear that both x-irradiation and trypan blue treatment obstruct development of the early preimplantation mouse embryo. (Diss. Abstr. Int., B)

41180 RADIOPROTECTION, TISSUE, AND CELLULAR UPTAKE OF COMBINATIONS OF DIMETHYLSULFOXIDE, S,2-AMINOETHYLISOTHIOUREA AND 5-HYDROXYTRYPTAMINE. Heal, Albert Vincent. Ann Arbor, Mich.; Univ. of Michigan (1971). 111p. University Microfilms Order No. 72-14,892. Thesis.

Swiss Webster female mice 35 and 70 days old weighing 25 ± 4 and 34 ± 3 grams, respectively, were used. The source of radiation was cobalt-60 with a dose rate of 80 rads per minute and a total absorbed dose of 1600 rads for all experiments. All drugs were made up just prior to injection and injected intraperitoneally five minutes before irradiation. AET was injected separately and first when used in various combinations. The three drug combination of DMSO, AET and 5-HT showed a synergistic protective effect (93.1% survival) which was found to be significant at the >99% confidence level. The $LD_{50/30}$ for the three drug combination in 35 and 70 day old mice is 1736 rads and 1893 rads, respectively. The $LD_{50/30}$ was 658 rads and 799 rads for untreated 35 and 70 day old mice, respectively. The three drug combination was found to have a dose reduction factor in 35 and 70 day old mice of 2.64 and 2.37, respectively. The uptake studies showed: a constant concentration of DMSO, AET and 5-HT in whole tissue and cell fractions for the two and three drug combinations for at least 55 minutes post-injection; a high concentration of DMSO in the nuclear fraction of the intestine; and, an increase in uptake of AET and DMSO in the three drug combination. Besides the protective effect of each drug, this author suggests the following to account for the synergistic effect of the combination of DMSO, AET and 5-HT: a prolonged decrease in nuclear oxygen in the intestine due to an increase in DMSO; a diminished metabolic activity and delay in DNA synthesis for a prolonged time in the cells allowing natural repair mechanisms to proceed; and, an increase in free radical scavenging, mixed disulfides and repair of damage by donation of a hydrogen atom due to an increase in uptake of DMSO and AET. (Diss. Abstr. Int., B)

41181 EFFECTS OF EPSILON-AMINO-n-CAPROIC ACID ON RADIATION-INDUCED INCREASE IN CAPILLARY PERMEABILITY AND SUBSEQUENT PATHOLOGY IN SKIN. Eassa, Eassa-Helmy Mohammed. Rochester, N. Y.; Univ. of Rochester (1971). 220p. University Microfilms Order No. 72-14,693. Thesis.

The temporal patterns and degrees of initial (within hours) and delayed (within 21 days) radiation-induced increases in capillary permeability in rabbit skin (blue dye flush in irradiated skin after iv injection of the vital dye Pontamine Sky-Blue 6BX) have been investigated after localized x-irradiation of rabbit skin with various single exposures ranging from 100 R to 4,000 R. The effect of single intravenous doses of epsilon-amino-n-caproic acid (EACA), administered at various times before and after x-ray exposure, on the temporal patterns and degrees of the radiation-induced increases in capillary permeability were studied. These experiments were followed by a multi-parameter investigation of the consequences of reduction of the radiation-induced increase in capillary permeability in skin by a single intravenous dose of EACA 15 minutes prior to irradiation (2,500 R), in terms of the degree of development, of the subsequent radiation-induced changes in connective tissue, vasculature, circulation, and epithelial structures in skin, leading to the permanent and delayed skin lesions during a 6-month period following irradiation. The studies included macroscopic, histopathological, biochemical (hydroxyproline and hexosamine determinations), and a new radioactive isotope technique, using ^{99m}Tc pertechnetate, for assessing microcirculatory capability of skin in terms of clearance time for intradermally injected isotope. Background literature was reviewed and the results discussed. The following conclusions have been drawn: The minimal single x-ray exposure to induce visibly detectable dye leakage (increased capillary permeability) in locally irradiated rabbit skin within 3 hours (initial period) is 450 R. The average time elapsing between irradiation and the first visible sign (blue flush) of increased capillary permeability is inversely dose-dependent, becoming shorter with higher exposures. The peak intensity of this effect was directly dose-dependent. Epsilon-amino-n-caproic acid, injected intravenously (0.30 g/kg body weight) at various times within the period from an hour before to an hour after irradiation, markedly decreased or completely abolished the initial (within hours) radiation-induced increase in capillary permeability. The effectiveness of the EACA was inversely related to the size of the radiation exposure and was most marked when given in the interval from 15 minutes before to 15 minutes after irradiation. Intravenous injection of EACA 15 minutes before irradiation (1,000 R) eliminated the second period (2 to 3 days) and reduced the degree and shortened the duration of the 3rd period (10 to 17 days) of increased capillary permeability. Intravenous injection of EACA just before irradiation (2,500 R), in markedly reducing the degree of radiation-induced increase in capillary permeability, markedly reduced also the degrees of subsequent connective tissue changes, vascular damage, circulatory impairment, acute skin lesions (dry and moist desquamation, ulceration, necrosis), and permanent or delayed skin lesions (atrophy of epidermis and adnexal structures, and fibrosis). The effects on epithelial structures are discussed in terms of direct versus indirect (mediated by vaculoconnective tissue changes) mechanisms. (Diss. Abstr. Int., B)

41182 EXPERIMENTAL INVESTIGATIONS ON THE MODE OF ACTION OF SUBSTANCES PROMOTING RADIORESISTANCE. **Langendorff, H. u. M. (Inst. fuer Experimentelle Biologie, Heiligenberg, Ger.). Strahlentherapie; 143: No. 4, 432-43(Apr 1972). (In German).**

To check the working hypothesis, which assumes that the adenylcyclase, cAMP, mechanism (Sutherland) plays an important role in the chemically induced increase of the radioresistance, irradiation experiments were performed on mice. The results of these experiments indicate that there are connections between the effect of known protective substances, promoting the radioresistance, and the mode of action found by Sutherland. (auth)

41183 LD$_{50}$(30)s AND DAILY DEATH DISTRIBUTIONS OF WHOLE OR PARTIAL BODY IRRADIATED MICE. Sato, F.; Tsuchihashi, S.; Nakamura, W.; Eto, H. (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 13: No. 2, 100-8(Jun 1972).

About 1300 mice were exposed to graded doses of x rays given by whole or partial body irradiation. For the partial body irradiation, the following three groups were assigned: head exposure, trunk exposure (chest and abdomen), and lower body exposure (pelvis, legs, and tail). LD$_{50}$(30)s were determined for each of the exposures. Daily death distributions after the exposure were observed in 30 days. The partial body irradiations produced specific daily death distributions, specific to the region exposed. The relative patterns of the daily death distributions were nearly independent of the doses over a wide range. Consequently there appeared plateaus in dose versus survival time curves after the head or the lower body exposure. The one after the head exposure could be attributed to oral death. There is no information on a cause of death for the plateau region of the lower body exposed group. (auth)

41184 RADIOBIOLOGICAL STUDIES ON CULTURED MOUSE BONE MARROW CELLS IN VITRO. Nikaido, O. (Kanazawa Univ., Japan); Horikawa, M.; Tanaka, T.; Sugahara, T. J. Radiat. Res.; 13: No. 2, 71-80(Jun 1972).

Bone marrow cells obtained from both femora of 30-day-old NC-mice were cultured stationarily for varying days in vitro to study the pattern of growth and differentiation of the hemopoietic cells. Within 10 days of culture, erythroid cells, myeloid cells, and lymphocyte-like cells disappeared from the culture, while the number of large mononuclear cells increased gradually with cultivation time and constituted about 98% of the total cell population at 10 days of culture. On the other hand, these cultured bone marrow cells showed neither protective ability to lethally irradiated mice nor colony forming ability in the spleen of recipient mice, when injected into 700 R-irradiated NC-mice. (auth)

41185 RADIATION EFFECTS ON CELL POPULATIONS IN THE INTESTINAL EPITHELIUM OF MICE AND ITS THEORY. Sato, F. (National Inst. of Radiological Sciences, Chiba, Japan); Muramatsu, S.; Tsuchihashi, S.; (and others). Cell Tissue Kinet.; 5: No. 3, 227-35(May 1972).

Mice were exposed to 1000 R of x-rays to their trunks and sacrificed every day up to the tenth day after exposure. Cell counts were made on histological sections of the duodenum. The cell counts in the crypts were reduced to about 50% of the control value on the first day after exposure. The cell counts began to recover on the third day and an overshoot of 170% was observed on the fourth day; thereafter the crypt cell counts tended to return to the control level. The cell counts on the villi reached their minimum value on the third day after exposure. Following an overshoot on the sixth day, the villus cell counts returned to the control level by the tenth day. The above experimental results were analyzed using a two-compartment model with a feedback term. A logistic proliferation was assumed for the proliferative crypt cells, while for the postmitotic villus cells the compartment was assumed to be a first in—first out type. The calculated results with this model are in general consistent with the experimental ones. The model seems to possess some essential features of the dynamics of cell renewal in the intestinal mucosa. (auth)

41186 HAEMOPOIETIC STEM CELLS IN EXPERIMENTAL HAEMOLYTIC ANAEMIA. Hodgson, G. S. (Cancer Inst., Melbourne); Bradley, T. R.; Telfer, P. A. Cell Tissue Kinet.; 5: No. 3, 283-8(May 1972).

Phenylhydrazine treatment produced an expansion of spleen CFU (10 × N) and an even greater expansion of spleen ACFU (40 × N). Blood CFU and ACFU levels also increased. While marrow CFU did not change marrow ACFU showed a pronounced drop. The ratio of ACFU/CFU varied between tissues, it was highest in marrow and lowest in peripheral blood. The changes in CFU, ACFU and blood granulocytes are discussed in relation to the radioprotective action of phenylhydrazine pretreatment of mice. (auth)

41187 REACTION OF NEUROSECRETORY CELLS TO LOCAL X-RAY IRRADIATION. Voitkevich, A. A.; Dedov, I. I. Arkh. Patol.; 34: No. 4, 27-34(1972). (In Russian).

The reaction of organelles in neurosecretory cells of the supraoptic nucleus of the hypothalamus to penetrating radiation was studied. A primary reaction to the exposure was activation of protein synthesis leading to formation of numerous granules in the Golgi complex. The next phase was characterized by disintegration of mitochondria, reduction of ribosomes, and partial fragmentation of granular reticulum. Simultaneously, more intensive formation of lysosomes in the Golgi apparatus was noted. During the reconstruction period of the submicroscopic organization of neurocytes the number of lysosomes was progressively reduced. Some aspects pertaining to the participation of lysosomes in irradiation alterations are discussed. (auth)

41188 EXPERIMENTS ON THE RADIATION PREVENTING EFFECT OF ANABOLIC STEROIDS. I. INFLUENCE OF DIANABOL ON THE POSTRADIOLOGICAL DISTURBANCES OF SINGLE PROTEIN FRACTIONS OF THE BLOOD SERUM. Panek, R. (Medical Academy, Bialystok, Poland). Strahlentherapie; 143: No. 2, 211-18(Feb 1972). (In German).

The influence of Dianabol on the postradiological disturbances of single protein fractions of the blood serum was examined in 620 white Wistar rats. It was observed that the extended Dianabol application does not change the total protein content of the blood. It causes a statistical significant decrease of the alpha globulin fraction from 16.9% to 10.0% and an increase of the beta globulin fraction from 11.4% to 26.6%. At the same time an increase of the properdin titer from 42.9 γN/ml serum to 46.7 γN/ml serum was observed. The radiation with 450 R and 650 R causes a step-like decrease of the total protein content, of the gamma globulin, and of the properdin as well as an increase of the alpha globulin fraction and of the haptoglobins. At the same time an increase of the cathepsin activity of liver and kidney tissue was observed. Animals treated with Dianabol showed less disturbances of the serum protein fractions during irradiation in comparison to controls. A decrease of the albumins, the gamma globulin, and the properdin was only observed after higher radiation doses. However, it did not reach the extent observed in controls. The radiation preventing effect on the alpha globulins and haptoglobin proved to be less effective. Rats treated with Dianabol showed less postradiological increase of the cathepsin activity. It is concluded that Dianabol decreases significantly the postradiological disturbances of the protein fraction of the blood serum, probably while increasing its synthesis and inhibiting the postradiological catabolism. The observed phenomenon is of essential importance for the mechanism of the radiation preventing effect of Dianabol. (auth)

41189 RESPONSE OF MOTONEURONS OF THE SPINAL CORD TO GAMMA RADIATION: A CYTOCHEMICAL STUDY. Olkowski, Z.; Manocha, S. L.; Bourne, G. H. (Emory Univ., Atlanta). Strahlentherapie; 143: No. 2, 202-10(Feb 1972).

The motor neurons of the mouse spinal cord were investigated cytochemically after total-body exposure of mice to gamma radiations of 636 R at a rate of 53 R/min/mouse, and mice were sacrificed at intervals of ½, 2, 4, 8 and 12 hours after irradiation. The AcPH and TPPase activity was enhanced within ½ hour, whereas the ATPase activity was significantly decreased. The IDPase activity was reduced in neurons as well as in the surrounding glia. The enzyme changes in the phosphatases and dehydrogenases indicated that the ionizing irradiations inhibit the oxidative phosphorylation in vivo and result in increase of the lysosomal content of the cell. The activity of studied dehydrogenases declined shortly after irradiation and picked up the activity after 8 to 12 hours, whereas the phosphorylase activity seemed to have been irrevocably reduced. The ionizing irradiations not only influenced the aerobic pathway and oxidative phosphorylation but also the pentose shunt and glycogen metabolism. The significance of these results was discussed. (auth)

41190 EFFECTS OF RADIATION ON MAMMALIAN CELLS. Wust, Carl J.; Riggsby, W. Stuart; Whitson, Gary L. (Univ. of Tennessee, Knoxville). pp 183-230 of Concepts in Radiation Cell Biology. /Whitson, Gary L. (ed.). New York; Academic Press Inc. (1972).

Based on the view that the use of radiations to interfere with normal cellular events will lead to a more definitive understanding of these normal cell processes, questions concerning various processes in mammalian cells are evaluated. The following areas of investigation are included in the discussion: the control of cell division; differences in the radiosensitivity of various phases of the cell cycle; the role of chromosome aberrations in mutation; target molecules responsible for radiation lethality; the basis for radiosensitivity of the immune response; and the molecular basis of radioinduced cancer. (E.R.B.)

41191 RADIATION INDUCED BOWEL DAMAGE IN RATS TREATED UNDER CONDITIONS OF AIR OR HYPERBARIC OXYGEN. Johnson, Richard J. R. (Lahey Clinic Foundation, Boston); Wiseman, Nathan; Hogg, Georgie R. Clin. Radiol.; 23: No. 1, 106-9(Jan 1972).

The use of hyperbaric oxygen in radiotherapy will only result in an improved therapeutic ratio if the tumor is hypoxic and normal tissue well oxygenated, since hypoxic normal cells, if present, will also undergo an increased radiation response. When the abdomen is irradiated, acute or chronic bowel damage may occur. If either the normal mucosa or submucosal cells were normally hypoxic, an increased incidence of damage might be expected with hyperbaric oxygen. Some reports of hyperbaric abdominal irradiation in man suggest an increase in incidence of late bowel damage. An experimental model was designed in which abdominal irradiation was administered to rats under either conditions of air breathing or hyperbaric oxygen. Mortality at 12 days was used as an assessment of mucosal damage, and late mortality to assess late bowel injury. No increase in early mortality was shown following hyperbaric irradiation, but late mortality was significantly increased in the hyperbaric group of animals. The significance of these findings and their relevance to the human situation are discussed. (auth)

41192 CURRENT STATUS OF FRENCH RESEARCH ON THE BIOLOGICAL EFFECTS OF HEAVY IONS IN COSMIC RADIATION AS OBSERVED IN HIGH-ALTITUDE BALLOONS. Miro, L. (CGE, Marcoussis, France); Deltour, G.; Pfister, A.; Kaiser, R.; Grandpierre, R. Life Sci. Space Res.; 8: 39-44(1970).

From twelfth plenary meeting of COSPAR; Prague, Czechoslovakia (11 May 1969). See CONF-690516.

On casual inspection, cosmic rays may not be considered to pose a biological hazard. Nevertheless, the heavy ion component does produce a significant but very local irradiation. This was confirmed by the hair whitening in black-haired animals. Experiments with black C57 mice in balloons at 30,000 m altitude show white-haired tufts along the tracks of heavy ions. Histological and radioautographic studies were carried out; the results are reported. Similar investigations on black rabbits gave similar results and confirm those obtained previously with black mice. In the discussion, we report that tissue damage is amplified. This fact is not yet explained, but suggests reconsideration of the calculation of radiation dosage. The ionization distribution induced by heavy ions is analyzed. We point out that along their tracks the dosage is very important; therefore it is necessary to investigate their biological action, particle by particle, according to their energy and their charge. (auth)

41193 RADIATSIONNAYA BIOKHIMIYA TIMUSA. (Radiation Biochemistry of the Thymus). Romantsev, E. F. Moscow; Atomizdat (1972). 176p.

The physical and biochemical mechanisms for the action of ionizing radiation on the thymus are reviewed. The thymus is thought to be one of the most radiosensitive of mammalian tissues, and this lymphoid tissue is associated with immunological reactions possessing important general biological significance. The action of ionizing radiation on the composition, structure, and functional activity of deoxyribonucleoprotein, on DNA synthesis, and on RNA metabolism are discussed. The synthesis of protein in the thymus of the irradiated animal and modifying factors in energy exchange in the thymus are considered. (619 references) (K.S.W.)

41194 EXPERIMENTAL FINDINGS ON ANIMALS CONCERNING THE RADIOSENSITIZATION IN IRRADIATION OF THE PARTIAL AND THE WHOLE BODY. Oberhausen-Braun, H. (Univ., Freiburg i. B.). Strahlentherapie; 143: No. 3, 281-92(Mar 1972). (In German).

In the experiment on the whole animal, oxidizing agents have induced a slight radio-sensitization, whereas they proved to be ineffective in the hypoxia experiment on tumor cells. Reducing compounds such as methylhydrazine sensitize the whole animal as well as tumor cells in situ. Mitotic inhibitory substances, as colcemid and urethane, seem to provoke a summation in adding the effects of drug and irradiation. The derivatives of vitamin K are selectively accumulated in the cells of certain tumors, and they can intensify the radiation effect 2.4 to 3.2 fold. In the range of higher doses, the mortality of mammalians, too, can be intensified by means of vitamin K derivatives. The latter effect is also seen when using riboflavin. Sulfhydryl-binding substances are able to augment the mortality of irradiated mammalians. A selective sensitization of tumor cells also is possible with N-ethylmaleimide. (auth)

41195 EFFECTS OF X-RAYS IN DIFFERENT PHASES OF THE HAIR CYCLES AFTER CASTRATION IN MICE. Epper, C. E.; Houssay, A. B.; Sancho, O. (Univ., Buenos Aires. Comision Nacional de la Energia Atomica, Buenos Aires). Acta Physiol. Latinoamer.; 21: No. 4, 303-9(1971).

The diffuse hair growth induced by gonadectomy in male C^3H/Ep mice was used to study the effects of x-ray radiation. Total irradiation with 200 rads one day after castration (hair follicles in telogen phase) produces a small loss of pigment and the dose of 400 rads produces, besides a very marked loss of pigment, a significant delay of hair growth. In animals irradiated with 200 or 400 rads, 6 or 11 days after castration (hair follicles in anagen) there was no difference compared to the controls. Partial irradiation with 400, 800 or 1200 rads one day after castration produces a very marked loss of pigment and a great delay in the hair growth. These effects are obtained with 800 or 1200 rads 6 days after castration, but if the same doses are given 11 days after castration, visible effects are only obtained with 1200 rads. These experiments show the different radiosensitivities according to the phase of the hair cycle, provoked simultaneously in every hair follicle by castration. The diffuse hair growth induced by gonadectomy is here proposed as a biological model to study the effects of radiation and of radiosensitizing or radioprotective drugs. (auth)

41196 MIGRATION OF CELLS FROM SHIELDED TO IRRADIATED MARROW. Maloney, Mary A.; Patt, Harvey M. (Univ. of California, San Francisco). Blood; 39: No. 6, 804-8(Jun 1972).

Studies were made with CBA T_6T_6 mouse chimeras to evaluate the contribution of migrating cells to the recovery of x-irradiated marrow. It was observed that cell migration from a shielded limb is essentially entirely responsible for the 30-day recovery of marrow irradiated with 1000 rad. Thus, these findings provide a direct demonstration of the generally accepted inference of stem cell migration from unirradiated to irradiated sites. (auth)

41197 RADIOPROTECTIVE AET AND THE MOUSE FETUS. Rugh, Roberts; Wohlfromm, Marlis (Columbia Univ., New York). Senten Ijo; 10: No. 3, 117-22(Sep 1970).

AET was given intraperitoneally to pregnant mice at 8 days gestation in order to determine whether the fetuses could be protected against the anomalies known to occur by irradiation with 200 R x-rays. The dose of AET used was far below the toxic level for the adults, and yet at a level of demonstrated protection for them. That AET or its degradation products did affect the fetuses is attested by the effects of this drug given without x-irradiation. AET alone caused an increase to 10% of incidence of the brain hernias. Moreover, AET administered 10 to 15 minutes prior to irradiation with 200 R x-rays, afforded no protection to the fetuses in terms of deaths, resorptions, and anomalies. The largest percentage of infant deaths and resorptions was found among those treated with AET and x-rays so that we must attribute a total lack of any protective effect of the AET for the fetus. These results suggest several alternative reasons why this may be the fact: high hydration of the fetus; effect of AET on DNA synthesis; effect on the mitotic index. It is hoped that the metabolic, hydration, or other differences between the fetus and the adult may suggest the pathway of effects of AET in the adult where it seems to be so effective. We have yet to find any drug which affords protection against x-irradiation to the fetus comparable to AET for the adult. (Japan)

41198 STUDIES OF RENAL FUNCTION OF IRRADIATED KIDNEY BY APPLYING RADIOISOTOPE RENOGRAPHY IN RABBITS. Takeda, Yusaku (Fukushima Medical Coll., Japan). Fukushima Igaku Zasshi; 20: No. 5-6, 257-70(Dec 1970). (In Japanese).

Serial renograms were obtained following single dose unilateral or bilateral renal irradiation in rabbits with 6 Mv x ray. The experimental animals were divided in three groups. Group 1 received 1000 rads in a single exposure to the left kidney. Abnormal renograms were first noted in the irradiated kidney at 10 months after irradiation. No abnormalities of renogram were recorded in the nonirradiated kidney of the same rabbit even at 40 weeks after irradiation. Group 2 received 3000 rads in a single exposure to the left kidney. In the renogram of the irradiated kidney, a temporary increase in the CM value of the secretory segment was noticed at 24 hours after irradiation. Increased renal blood flow (RBF) could account for this increased amplitude of the secretory segment. However, the renal function of the irradiated side was depressed progressively after initial temporary increase in the CM value, reaching the minimal level 20 weeks after irradiation. On the contrary, the renal function of the non-irradiated side fell precipitously at 1 to 3 weeks after irradiation and at 14 weeks it returned to the level of normal function. The explanation for this phenomenon of the depression in the renal function of the non-irradiated side could not be clarified. No histologic abnormalities were noted to explain this phenomenon. Group 3 received 3000 rads in a single exposure to bilateral kidneys. The function of bilateral irradiated kidneys was rapidly depressed soon after irradiation, furthermore it reached the minimal level at 11 days. (auth) (Japan)

41199 EFFECT OF RADIOSENSITIZERS ON BACTERIAL INFECTION IN MICE IRRADIATED WITH X-RAY. Yamaguchi, Shoji (Nihon Univ., Tokyo). Nichidai Igaku Zasshi; 30: No. 4, 312-42(Apr 1971). (In Japanese).

In an attempt to elucidate whether sensitizers can enhance the injurious action of heavy x ray irradiation on defense mechanisms against bacterial infections, the effects of hydrogen peroxide and 5-fluorouracil on Pseudomonas aeruginosa infection in mice following exposure to varying doses of x ray were observed on the basis of the number of surviving mice and days of their survival, and the detection of the infecting bacilli in various organs such as the liver, spleen, kidneys, and blood. The bacilli were given intraperitoneally, subcutaneously or orally to mice on the 3rd day after x-irradiation. From the results obtained, it was concluded that the administration of these radiosensitizers prior to the x ray irradiation in large doses enhanced the untoward effect of heavy irradiation and lowered the resistance to infection with Pseudomonas aeruginosa. The degree of resistance-lowering effect was related to the x ray dose.

The effect of local irradiation was inferior to that of whole-body irradiation. The culture experiments, which had been made on the animals found to have the infecting bacilli in their various organs, showed that no organ-specificity occurred in such animals. (auth) (Japan)

41200 EARLY EFFECTS OF RADIATION ON THE GASTRIC MUCOSA. Hirose, Fumio (Hiroshima Univ.). Gan No. Rinsho; 16: No. 6, 628-33(Jun 1970). (In Japanese).

Effect of radiation on gastric mucosa was examined in 30 male CF mice of 63 to 68 days of age by a single irradiation of 2000 rads of x-rays administered to the stomach. All the animals were given intravenous injections of 2 μCi/g of ^{3}H-thymidine before killing, and the animals were killed 1, 3, 6, 12, 18, or 24 hours, and 2, 3, 4, 5, 7, 10, 15, 20, or 30 days after irradiation. The stomachs removed from these animals were prepared for optic microscopy and autoradiography. Decreased incorporation of ^{3}H-thymidine and inhibition of mitosis were observed one hour after irradiation; nuclear dilatation and destruction became evident after 3 hours, and these phenomena became more marked after 6 hours. These cellular damages were seen markedly in fundus glandular mucous neck cells near the pylorus 12 hours later. After 2 days, atrophy of the mucosa near the pylorus and formation of ulcer started, and initiation of regeneration of glandular tissue became apparent in the atrophied mucosa after 5 days. Ulcer formation and its regeneration were observed in the glandular stomach mucosa after 7 days, and atypical epithelial cells appeared in the markedly injured mucosa after 15 days. Strongly atypical megakaryocytes showed weak incorporation of ^{3}H-thymidine but slightly atypical cells showed active incorporation. After 30 days, atypical proliferation of mucosa near the pylorus, appearance of atypical epithelial cells, and abnormal arrangement of proliferating epithelial cells were observed. (Japan)

41201 INDUCTION OF CHROMOSOME ABERRATIONS BY IN VIVO AND IN VITRO GAMMA-IRRADIATION OF SWINE LEUKOCYTES. McFee, A. F.; Banner, M. W.; Sherrill, Mary N. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Int. J. Radiat. Biol.; 21: No. 6, 513-20(Jun 1972).

Chromosome aberration rates were determined among cultured leukocytes taken from swine immediately after their exposure to 100, 200, or 400 R of γ radiation and from samples of their blood simultaneously exposed in vitro to like doses. The higher rates obtained from in vitro samples seemed in line with the expected influence of body-shielding on in vivo cells. A pronounced variation among individual animals was obvious, especially at the higher doses. Coefficients for single-break aberration induction were within range of those reported for human cells, whereas rings and dicentrics were somewhat lower than those for man. (auth) (UK)

41202 SURVIVAL CHARACTERISTICS OF STEM CELLS OF GASTRIC MUCOSA IN C_3H MICE SUBJECTED TO LOCALIZED GAMMA IRRADIATION. Chen, Kuang Y.; Withers, H. Rodney (Univ. of Texas, Houston). Int. J. Radiat. Biol.; 21: No. 6, 521-34(Jun 1972).

The dose-survival characteristics of gastric stem cells were assayed in the mouse using an in situ cell cloning technique. The value for D_0 was 137 rads. The repair capacity as measured in split-dose experiments was great. Of the total sublethal injury repaired, about two-thirds was completed within the first hour. Regeneration began promptly after an initial radiation injury, the surviving clonogenic cells doubling every 43 hr. The influence of these dose-survival and regeneration characteristics on the response of mouse stomach to a variety of dose-fractionation regimens was investigated and their relevance to radiotherapy discussed briefly. (auth) (UK)

41203 BONE REGENERATION IN EXPERIMENTAL ANIMALS AFTER RADIATION EXPOSURE. Schlegel, D.; Helfrich, J.; Klemm, H.; Schreckenberger, H. (Univ., Munich. Medical Coll., Hanover). Electromedica; No. 1, 26-8(1972).

Using high-energy radiation (GAMMATRON 2, manufactured by Siemens), the bone regeneration in experimental lesions in the legs of dogs was investigated by means of x-ray examinations, histological and photometric techniques and labelling with tetracycline. An increasing inhibition of callus formation was demonstrated, this effect being dependent upon the radiation dose administered. The experimental model described here is suitable for utilization in the working out of bone-conserving high-energy radiation procedures. (auth)

41204 MACRO-COLONY ASSAY FOR MEASUREMENT OF REPARATIVE ANGIOGENESIS AFTER X IRRADIATION. Van Den Brenk, H. A. S. (Saint Thomas' Hospital, London). Int. J. Radiat. Biol.; 21: No. 6, 607-11(Jun 1972).

A method is described in which vascular macro-colonies were formed after irradiation in granuloma pouches constructed in subcutaneous tissue of rats using the Selye technique. This method was used to obtain radiation dose survival data for reparative angiogenesis and to calculate parameters of radiosensitivity of vascular endothelium in vivo. Each pouch and adjacent tissue ~1 cm wide was irradiated with x ray doses from 1000 to 2200 rads, 5 min after the pouch has been roused. The rats were killed 13 days later and the incidence of colonies scored. The colonies were found to decrease with increase in radiation dose. (UK)

41205 EXTRACORPOREAL IRRADIATION OF THE BLOOD AND CORNEAL TRANSPLANTATION. A SURVEY WITH A REPORT OF THE FIRST CASE. Krogh, E.; Weeke, E. (Rigshospitalet, Copenhagen). Acta Ophthalmol.; 50: 102-10(1972).

A brief discussion of the delayed type cellular hypersensitivity with special regard to graft rejection is given. Various methods of suppressing this process are mentioned, followed by a description of one of the more specific and clinically promising methods, namely extracorporeal irradiation of the blood (ECIB). The first known case in which ECIB was performed prior to and after a corneal transplantation in rabbits is reported. The favorable result, although not conclusive, should stimulate further controlled investigation. (auth)

41206 EXPERIMENTS ON THE RADIATION PREVENTING EFFECT OF ANABOLIC STEROIDS. II. THE INFLUENCE OF DIANABOL UPON DISTURBANCES OF THE TISSUE METABOLISM AND UPON THE POSTRADIOLOGICAL TOXEMIA. Panek, R. (Medical Academy, Bialystok, Poland). Strahlentherapie; 143: No. 4, 444-53(Apr 1972). (In German).

The influence of dianabol on the metabolism in homogenates and the mitochondrial fractions of the liver and kidney tissue of irradiated rats was examined, as well as the intensity of radioinduced toxemia based on the orthochinone- and lipoidperoxyd levels of the blood serum. 560 Wistar rats were used in the experiment. It was observed that the 20-day application of dianabol does not cause any essential changes of the metabolism of liver homogenates. On the other hand, it decreases statistically significantly the metabolism of the kidney homogenate and mitochondrial fraction of liver and kidney, respectively. The radiation does not change the metabolism of the mitochondrial fraction. However, an increased oxygen consumption and an increased CO_2 secretion by the liver homogenate and an increased CO_2 secretion by the kidney homogenate were observed. The radiation also caused a statistically significant increase of the radiotoxin content of the blood serum and of the tissue in the examined animals. Animals treated with dianabol showed less disturbance of the oxygen consumption and of the CO_2 secretion mainly in the tissue homogenates after irradiation. From the experiments reported here one could draw the conclusion that the disturbances of the tissue metabolism after prolonged application of dianabol are a consequence of the metabolic effect of this substance. It seems as if dianabol changes the cell metabolism by making it more radioresistant. This is confirmed by the inhibition of the postradiological metabolism disturbances and the intensified postradiological toxemia. The observed effect probably is of importance for the mechanism of the radioprotective effect of dianabol. (auth)

41207 GLYCOGEN CHANGES IN BONE MARROW NERVES AFTER WHOLE-BODY X-IRRADIATION. Calvo, Wenceslao; Forteza-Vila, Jeronimo (Univ., Ulm, Ger.). Acta Neuropathol.; 20: No. 1, 78-83(1972).

Whole body x-irradiation of rats with 400 rads produced accumulation of glycogen in the nerves of the bone marrow. The glycogen was demonstrated as dense granules 200 to 400 Å in diameter. These granules were present in myelinated, nonmyelinated axons and Schwann cells of the marrow nerves from the first to the thirtieth day after irradiation. About one-third of the axons were affected. In normal animals only 5.9% of the nonmyelinated axons showed glycogen, while this substance was not demonstrable in myelinated fibers. (auth)

41208 CHANGES IN THE SPECIFIC GRAVITY OF RABBIT BRAIN AFTER HIGH DOSES OF X IRRADIATION. Leith, John T.; Gaugl, John F. (Univ. of California, Berkeley). Int. J. Radiat. Biol.; 21: No. 6, 573-82(Jun 1972).

Changes in specific gravity of different areas of rabbit brain were studied after exposure to 10 krads of x rays to the head only. A triphasic change in brain specific gravity was found, i.e. a decrease from 0 to 1.5 hr after irradiation followed by a short-lived rise to approximately pre-irradiation values at 2 hr after irradiation, and then a developing second decrease to 6 hr after irradiation. The initial decrease and short-lived increase in brain specific gravity appeared to be due primarily to disturbances in circulatory relationships of the central nervous system, whereas the second decrease seemed to be due to a developing defect in brain permeability, as indicated by increased protein levels in the aqueous humour and cerebrospinal fluid, and by a developing brain oedema. (auth) (UK)

41209 RADIOSENSITIVITY OF HAEMOPOIESIS IN FISH. II. STUDIES AT 18° AND 10°C. Lockner, D.; Pettersson, A.;

Ericson, U. (Karolinska Institutet, Stockholm). Int. J. Radiat. Biol.; 21: No. 6, 559-72(Jun 1972).

Radiosensitivity of extramedullary haemopoiesis of tench (Tinca vulgaris, Fleming) was studied at 10° and at 18°C. The LD 50/30 was found to be 1200 rads at 18° and 55,000 rads at 10°C. About 1100 rads reduced red-cell values and ^{59}Fe incorporation into erythrocytes to 50% at 18°. At 10° these values were not influenced by doses up to 55,000 rads. At 18° leucocytes were depressed by about 100 rads to 50%. At 10° about 16,000 rads were needed for the same effect. Radiation death in tench was thought to be caused partly by the effect on the white blood cells. (auth) (UK)

41210 EARLY MORPHOLOGICAL CHANGES IN CORTICAL MEDULLARY THYMOCYTES OF THE RAT AFTER WHOLE-BODY IRRADIATION. I. ELECTRON-MICROSCOPE OBSERVATIONS. Aoyama, Takashi (Nagasaki Univ., Japan); Kawamoto, Yoshio; Furuta, Iwao; Kondo, Teruo. Int. J. Radiat. Biol.; 21: No. 6, 545-58(Jun 1972).

Electron-microscope observations revealed that the early morphological change which precedes pyknosis in rat thymocytes after whole-body x irradiation with 1000 R was the alteration of nuclear shape by increased nuclear indentation, followed by loss of the typical chromatin pattern in the nucleus. It was confirmed that radiation caused destruction of more thymocytes in the cortex than in the medulla. In the normal medulla, the following three structures were observed: narrow channels between the reticular cell and the thymocyte, or between thymocytes; a structure resembling a tight junction between the thymocyte and the reticular cell, suggesting a transfer of substance between the cells; and rows of small vesicles in the reticular cells and the thymocytes. The mechanisms of the radiation-induced destruction of thymocytes, and the different radiosensitivity of cortical and medullary thymocytes, are discussed in relation to cellular structure. (auth) (UK)

41211 MECHANISMS OF RADIOPROTECTION OF MICE BY PHENYLHYDRAZINE. Smith, L. H.; McKinley, T. W. Jr. (Oak Ridge National Lab., Tenn.). Radiat. Res.; 50: No. 3, 611-28 (Jun 1972).

Phenylhydrazine is a radioprotector when injected into mice 6 to 11 days before exposure to x rays. To better define the basis for radioprotection, the following studies were made: effects of phenylhydrazine on $LD_{50(30)}$, hemopoietic regeneration in irradiated mice, hemopoiesis of unirradiated mice, hemopoietic cell radiosensitivity, and life-span of protected mice. Injection of 3.0 mg of the drug a week before irradiation increased the $LD_{50(30)}$ by 140 R, which is equivalent to a dose reduction factor of about 1.2. Phenylhydrazine-treated mice survive because of hematologic recovery that becomes manifest 2 weeks after irradiation. Some of the results are consistent with the hypothesis that radioprotection by phenylhydrazine is the result of increased numbers of hemopoietic stem cells in the spleen at the time of irradiation. However, some of the colony-forming unit and splenectomy data indicate that this increase may not be the sole basis for protection, although it is clear that the spleen is involved. Protection by phenylhydrazine does not appear to be related to an increase in radioresistance of hemopoietic stem cells (colony-forming units) or to hypoxia resulting from anemia or from methemoglobin formation. (auth)

41212 TRYPANOSOMA BRUCEI: FLUXES OF THE MORPHOLOGICAL VARIANTS IN INTACT AND X-IRRADIATED MICE. Balber, Andrew E. (Rockefeller Univ., New York). Exp. Parasitol.; 31: No. 2, 307-19(1972).

The number of dividing, slender, intermediate, and stumpy forms of Trypanosoma brucei in the blood of inbred mice changed daily. In both intact mice and mice which were exposed to whole body x-irradiation before infection, slender and dividing forms predominated during the first 72 hr of infection, and the number of intermediate and stumpy forms increased to a maximum between 72 and 140 hr. The rate at which stumpy forms accumulated in the blood and the number of these forms which eventually circulated were the same in both groups. However, the fluxes in the number of slender and dividing forms differed in intact and x-irradiated mice. In intact mice, the number of dividing forms in the blood decreased between 72 and 140 hr, and the number of slender forms decreased between 96 and 140 hr. In x-irradiated mice, the number of both these forms increased throughout infection. Electrophoresis of serum proteins and agglutination tests showed that x-irradiation severely depressed the ability of the mice to make antibody. Homogenates of spleen and bone marrow of intact mice contained many dividing forms throughout the infection. It is concluded that although host antibody does not directly induce the transformation of slender forms into stumpy forms, it may influence the morphological composition of the peripheral blood population of trypanosomes in several ways. (auth)

41213 EFFECT OF CIRCADIAN RHYTHM ON THE RADIATION RESPONSE OF THE CHINESE HAMSTER (CRICETULUS GRISEUS). Lappenbusch, William L. (Environmental Protection Agency, Rockville, Md.). Radiat. Res.; 50: No. 3, 600-10(Jun 1972).

More than 1000 Chinese hamsters, 80 days old, were used to examine the radiation response of Cricetulus griseus at different times during a 24 hour day. The $LD_{50/30}$ values were calculated to be 954 rads (1 AM), 889 rads (9 AM), 823 rads (11 AM), 886 rads (1 PM), and 882 rads (3 PM). Three studies were made to attempt to explain the differences in radiosensitivity: examination of the mitotic indices of white blood cells (WBC) in the bone marrow which showed that the rate of mitosis fluctuated markedly over a 24 hour period, the highest (11 AM) and lowest (1 AM) mitotic index corresponding to the lowest and highest $LD_{50/30}$ value, respectively, revealing a linear correlation between $LD_{50/30}$ values and rates of mitosis; analysis of the peripheral blood of hamsters irradiated at a time when the mitotic index of WBC was either low or high which showed that the restoration performance of the circulating WBC density coincided exactly with the inverse of the rate of mitosis during exposure; and calculation of RBC production after exposure which showed that the rate of ^{59}Fe uptake is higher in animals irradiated at 1 AM than 1 PM. This study clearly points out the importance of exposing the animals at precisely the same time each day if more than one exposure is required. (auth)

41214 EFFECT OF WHOLE-BODY IRRADIATION AND PUROMYCIN ON HYDROLYTIC ENZYME ACTIVATION IN REGENERATING RAT LIVER. Paris, J. E. (Tufts Univ., Boston). Radiat. Res.; 50: No. 3, 592-9(Jun 1972).

The effects of whole-body gamma irradiation, which blocks DNA synthesis, and puromycin, a protein synthesis inhibitor, on total organ activities of three acid hydrolases of regenerating, radiosensitive rat liver, were studied. Doses of 1000 or 10,000 rads, given immediately or 6 hours after subtotal hepatectomy, failed to prevent the twofold increase in total organ activities normally elicited by partial hepatectomy. Puromycin, injected every 3 hours in amounts large enough to inhibit protein synthesis, was also not effective. The observed rise of total organ hydrolase activities in regenerating liver may be due to selective removal of natural inhibitors of the enzymes, or to some form of enzyme activation. The process is not sensitive to gamma irradiation or protein synthesis arrest. (auth)

41215 INTESTINAL CRYPT SURVIVAL AND TOTAL PER CRYPT LEVELS OF PROLIFERATIVE CELLULARITY FOLLOWING IRRADIATION: ROLE OF CRYPT CELLULARITY. Hagemann, Ronald F.; Sigdestad, Curtis P.; Lesher, S. (Allegheny General Hospital, Pittsburgh). Contract AT(30-1)-4247. Radiat. Res.; 50: No. 3, 583-91(Jun 1972).

Mice were given whole-body exposures of 500 R, or abdomen-only exposures of 900 R. One or 4 days later, when intestinal crypt cellularity was either relatively low or high, respectively, a graded series of exposures was given, and crypt survival and total and per crypt levels of proliferative cellularity measured 3 days thereafter. Crypt cell survival was found to be markedly affected by crypt cellularity existing at the time of irradiation. Advantage may be taken of the compensatory proliferative intestinal response following a given radiation exposure to ameliorate somewhat the efficacy of a subsequent exposure for crypt killing. A precise analysis of the relationship between proliferative and crypt progenitor compartment sizes was thwarted, however, by an apparent increase in D_0 of cells surviving the conditioning exposure. The difference in D_0's was marginally significant when determined 3 days after 500 R, and not significant 1 or 4 days after 900 R. At high radiation exposures, the proliferation rate of cells in surviving crypts was markedly reduced, in spite of a continued stimulus for accelerated proliferation. This suggests that a condition relating to growth, possibly analogous to small colony formation seen in vitro, exists in the heavily irradiated mammalian intestine. (auth)

41216 EFFECT OF HIGH-ENERGY X-RAY AND PULSED GAMMA-NEUTRON RADIATION ON BRAIN BLOOD FLOW, VASCULAR RESISTANCE, BLOOD PRESSURE, AND HEART RATE IN MONKEYS. Nathan, M. A.; Craig, Dan J. (Air Force School of Aerospace Medicine, Brooks Air Force Base, Tex.). Radiat. Res.; 50: No. 3, 543-55(Jun 1972).

Ten chloralose-anesthetized rhesus monkeys were exposed to a total of 10 krads of 6-MeV x rays administered in 1000-rad increments at an average of 158 rads/min. A second group of three monkeys was exposed to 2.5 krads of pulsed gamma-neutron radiation. Statistical comparisons were made between each exposure group and a sham-irradiated control group consisting of seven monkeys. Tachycardia and hypotension developed after 1.1 krads of x-ray. With 2.5 krads of gamma-neutron exposure, tachycardia developed after 1 minute and hypotension developed after 2 minutes. Therefore, the effect of intermediate-dose-rate high-energy x-ray and pulsed gamma-neutron irradiation appears dependent only on cumulative dose. It was shown that damage to baroceptor reflexes may contribute to the development of hypotension. Exposure to 2.1 krads of x-ray resulted in a significant decrease of brain blood flow. In contrast to x-ray exposure, for the first 5 minutes after gamma-neutron irradiation, brain blood flow increased, but at 20–25 minutes postexposure blood flow had decreased significantly. Lack of compensatory changes in brain vascular resistance was attributed to direct damage to brain autoregulatory mechanisms, and/or to the opposing effects of radiation-induced hypocapnia. (auth)

Invertebrates

Refer also to abstracts 41051 and 41065.

41217 (AEC-tr-7307, pp 68-75) RADIOBIOLOGICAL REACTIONS OF AMOEBAE WITH FEW CHROMOSOMES. Korogodina, Yu. V.; Korogodin, V. I. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). Translated from Radiobiologiya; 11: No. 6, 865-70(1971).

It is shown that the amoeba Entamoeba moshkovskii, which has few chromosomes, is characterized by a high radioresistance and the presence of a large "shoulder" on the viability curves (for amoebae in the stationary phase of culture growth $LD_{50\%} = 400$, $D_Q = 500$, and $D_0 = 60$ krad, whereas for amoebae in the logarithmic phase $LD_{50\%} = 780$, $D_Q = 670$, and $D_0 = 190$ krad). A temperature decrease during or after irradiation to 2 to 4°C with a subsequent rise to the optimum level of 25° exerts no influence on the radiosensitivity of these amoebae. In the range 500 to 900 krad a considerable part of the lethally damaged cells perish and experience lysis during the first days after irradiation, prior to mitosis. Some of the cells surviving after irradiation in these doses during subsequent multiplication form clones with few cells whose number is the greater the more intense the irradiation dose. The authors discuss the possible reasons for such radiobiological reactions in amoebae with few chromosomes. (tr-auth)

41218 (AEC-tr-7307, pp 113-18) CORRELATION IN RADIOSENSITIVITY CHANGES DURING THE EARLY EMBRYOGENESIS OF THE SEA URCHIN STRONGYLOCENTROTUS NUDUS AND FLUCTUATIONS OF CELL THIOL CONTENT. Tarasenko, A. G.; Nekrasova, I. V.; Novoselova, L. F. (Chemistry Faculty of Moscow State Univ. Inst. of Evolutionary Biology, Moscow). Translated from Radiobiologiya; 11: No. 6, 900-3(1971).

The radiosensitivity of the developing eggs of a sea urchin correlates with the change in level of thiols. It is shown that the most radiotolerant stage in the cell cycle is the metaphase, which is characterized by the highest content of thiols. The radiosensitive stage in the cycle, the telophase, corresponds to a lower level of thiols. The change in radiosensitivity of the eggs observed during the course of segmentation is associated with fluctuations in the level of the thiols present in the blastomere and does not correlate with the change in the content of thiols in the cell membranes. (tr-auth)

41219 (AEC-tr-7307, pp 166-9) EFFECT OF BACKGROUND DOSES OF GAMMA IRRADIATION ON THE RATE OF DIVISION OF INFUSORIANS. Kozlov, A. A. Inst. of Experimental Morphology, Tbilisi, USSR). Translated from Radiobiologiya; 11: No. 6, 935-7(1971).

It was demonstrated that even an insignificant increase in the intensity of penetrating radiation decreased the period of cell division. It was possible to determine the time during which the cell awaits a sufficiently high-energy particle triggering the division process. (tr-auth)

41220 (ORNL-TM-3628) BIOLOGY DIVISION HABROBRACON EXPERIMENT P-1079. Annual Progress Report to the National Aeronautics and Space Administration, January 1–December 31, 1968. (Oak Ridge National Lab., Tenn.). 34p. Dep. NTIS.

It was shown for the Habrobracon experiment in the Biosatellite II spacecraft that the scattered γ radiation with an energy of less than 100 keV accounted for less than 1% of the exposure received by the 4000-R nominal exposure package. The scattered radiation accounted for less than 2% of the exposure received by the 500-R nominal exposure package. The radiation doses were measured using Toshiba glass rods loaded at different positions. Conversion factors were obtained which permitted corrections for the geometry and the scattered radiation. (auth)

41221 (PRNC-151) INSECT STERILITY PROGRAM. Technical Report No. 6, September 1970–January 1972. Walker, David M. (Puerto Rico Nuclear Center, Mayaguez). Jan 1972. Contract AT(40-1)-1833. 80p. Dep. NTIS.

Experiments demonstrated that the sugarcane borer (Diatraea saccharalis) could be sterilized by gamma radiation and field tests showed that this might be practicable as a means of eradication of this species. The high cost of production and other problems preventing a high degree of efficiency in the use of this method are pointed out. The use of sub-sterilizing doses of gamma radiation was found to have advantages over the release of fully sterile individuals. This method of inherited partial sterility has been applied to other insects. It is believed that long-term effects over successive generations is due primarily to point mutations, translocations, and breaks. Rearing methods are described for the following insects: sugarcane borer (Diatraea saccharalis), yellow striped armyworm (Prodenia ornithogalli), pega pega (Lamprosema indicata), and green stink bug (Nezara viridula). Tables and figures are presented to show mating lineages and reproductive potential of sugarcane borer lines following exposure of the parent generation to various radiation doses. Some conclusions drawn from preliminary tests are as follows: although the survival rate of the egg stage in the first and second generations is reduced at higher doses, the survival rate of ensuing generations is not; in non-afflicted lines there is very little embryonic death and larval mortality is highest in the first stage with less in the fifth stage and the pupal stage; female lines are capable of transmitting, or conversely surviving, inherited partial sterility factors, but to a less extent than male lines; development rate in afflicted larvae was considerably longer than in normal larvae; inherited partial sterility factors are apparently not selected against; and no phenotypic abnormalities were observed. Preliminary tests were carried out on the effects of dose fractionation on adults of sugarcane borers and armyworms and the effects of juvenile hormone B and ecdysterone were evaluated with larval sugarcane borers. (H.L.W.)

41222 GENETIC STUDIES OF A MICRO REGION OF CHROMOSOME IIIR OF DROSOPHILA MELANOGASTER. Deland, Michael Campbell. Storrs, Conn.; Univ. of Connecticut (1971). 87p. University Microfilms Order No. 72-14,225. Thesis.

Prior studies centering on the rosy gene in chromosome IIIR of Drosophila melanogaster (Chovnick 1966, Schalet et al., 1964) had provided a highly developed genetic region extending from karmoisin at 51.7 to 1(3)26 at 52.2. This project represents an attempt to detect and localize any remaining detectable functional sites in the region and to examine mutant alleles of these sites for survival as homozygotes in cells of the eye. The test system utilized the technique of x-ray induced somatic crossing over following the procedures of Becker (1960) and the classical somatic mosaicism resulting from somatic segregation following such exchange (Stern 1936). The ethyl methanesulphonate (EMS) mutagenesis scheme was comprised of two parts. The first part was designed to detect any recessive visible or recessive lethal mutations in the region. The second part relied on the ability of this mutagen to produce a high proportion of first generation mosaics (Epler 1966), to detect those recessive lethal sites in the region which were capable of producing mutant alleles which were non autonomous in the gonadal tissue. In the first part of the mutagenesis scheme 2,220 mutagenized third chromosomes were sampled and yielded 38 confirmed mutations of the rosy region. Out of the 1,992 mutagenized third chromosomes sampled in the second part of the mutagenesis scheme, only 3 confirmed mutations of the rosy region were recovered. All new mutants were positioned within the region by complementation with a set of overlapping deletions. Of the total of 41 mutants recovered, one was a double mutant affecting a previously known site as well as a new complex site, 17 were alleles of this same complex, 2 were alleles of a new site, 4 were deficiencies which served to indicate the presence of an additional 3 functional loci. A new position was assigned to the piccolo locus on the basis of evidence provided by 3 new alleles of that locus. Chromosomes bearing mutants of 17 loci including 7 members of the new complex were tested in the eye mosaic system, in the expectation that non random behavior with respect to position of the mutations within the region might reveal coordinated function of adjacent sites. The system proved to be unsuitable for comparisons between loci, but demonstrated a potential sensitivity for use in comparing mutant alleles within a locus. The relationship between the number of detectable functional sites and the number of cytological bands in the region was discussed. (Diss. Abstr. Int., B)

41223 GENETIC LOADS IN TWO HOUSE FLY POPULATIONS TREATED WITH SUBSTERILIZING DOSES OF X-RAYS FOR THIRTY-TWO GENERATIONS. Flint, Hollis M.; McDonald, Ian C. (Agricultural Research Service, Fargo, N. Dak.). Ann. Entomol. Soc. Amer.; 65: No. 3, 594-7(May 1972).

Three colonies of the house fly, Musca domestica L. (Diptera: Muscidae), were established from an Orlando, Florida, wild-type stock to study the cumulative effects of substerilizing doses of x-rays on house fly populations. Two of the colonies were subjected to irradiation pressure in each generation for 32 generations while the 3rd colony received no irradiation and served as a control. In one irradiated colony untreated females from each generation were mated with x-rayed males (1.2 kR) from the parental Orlando stock. In the 2nd irradiated colony, males and females were crossed inter se in every generation following the treatment of males with 1.2 kR of x-rays. Egg hatchability in the irradiated colonies decreased from an average of 60 to 20% during the study, but quickly returned to the level of the control colony when treatments were discontinued. The treated colonies also had a reduced but relatively constant level of larva-to-adult survival (about 75–90%) compared with the control colony, but the lifespan of adults of the F_{26} generation was not adversely affected. Males with irradiation histories were not as sexually competitive as males from the Orlando stock, based on egg hatch percents recorded when irradiated males and untreated males and females were combined. Tests with flies of the F_{26} generation indicated that x-irradiation altered the frequency of deleterious recessive mutations on autosome III in the irradiated colonies when compared to the control colony. (auth)

41224 RADIATION-INDUCED BIOCHEMICAL CHANGES IN PROTOZOA. Whitson, Gary L. (University of Tennessee, Knoxville). pp 123-51 of Concepts in Radiation Cell Biology. /Whitson, Gary L. (ed.). New York: Academic Press Inc. (1972).

Studies on the radiation biochemistry of the protozoa to date have included research on DNA, RNA, and proteins. In vivo experiments with DNA have dealt primarily with the effects of nonionizing radiations (uv) on content, synthesis, and production and fate of pyrimidine dimers in DNA. Studies on both the chromatographic isolation of pyrimidine dimers and the repair replication of DNA in certain protozoan cells indicate that there are efficient repair mechanisms involved in dark repair and photoreactivation. There have been a few studies on RNA in certain protozoan cells following irradiation, but these have dealt primarily with content and synthesis rather than any alteration in structure. The main discovery that has come out of RNA studies is that RNA is necessary for cell regeneration and cell division. Less is known concerning the effects of radiation on proteins. Most of these studies, which were done mainly on enzyme activities, indicate that proteins in vivo are in general very resistant to ionizing radiations. Very few relationships have been established concerning direct biochemical changes in macromolecules as a basis for alteration of biological activities, e.g., ciliary immobilization, prevention and delays of cell division, inhibition of regeneration, and lethality. Findings from other cellular studies in radiation biochemistry suggest the possibility that changes in SH compounds and alteration of cell membranes may be important targets for ionizing radiations in protozoan cells. (auth)

41225 TECHNIQUES FOR THE ANALYSIS OF RADIATION-INDUCED MITOTIC DELAY IN SYNCHRONOUSLY DIVIDING SEA URCHIN EGGS. Rustad, Ronald C. (Case Western Reserve Univ., Cleveland). pp 153-81 of Concepts in Radiation Cell Biology. /Whitson, Gary L. (ed.). New York: Academic Press Inc. (1972).

The sea urchin egg offers some unusual opportunities for quantitative studies in radiation biology, because the division is highly synchronous, the gametes may be irradiated separately, recovery occurs in unfertilized eggs outside the mitotic cycle, and the mitotic cycle may be exceptionally simple in that no mass doubling occurs and RNA synthesis does not seem essential. However, such factors as the large size of the egg, its low permeability, and its large precursor pools hamper some types of physiological and biochemical studies. Nonetheless, until the methods of artificially synchronizing exponentially growing cell populations are vastly improved, the sea urchin egg will remain one of the most useful cells for the quantitative analysis of radiation-induced mitotic delay. (auth)

41226 BIOLOGICAL RESPONSES OF HABROBRACON TO SPACEFLIGHT. von Borstel, R. C. (Oak Ridge National Lab., Tenn.); Smith, Roger H.; Whiting, Anna R.; Grosch, Daniel S. Life Sci. Space Res.; 8: 6-11(1970).

From twelfth plenary meeting of COSPAR; Prague, Czechoslovakia (11 May 1969). See CONF-690516.

Since the interaction of the parasitic wasp Habrobracon with the space environment could not be prejudged, we decided to test approximately 30 different parameters of a genetic, mutational, biochemical, behavioral, and physiological character in the one spaceflight we had at our disposal. These parameters were examined at six different exposures of γ radiation (including 0 dose) in flight, resulting in about 180 different endpoints in all. The most profound effects of spaceflight in conjunction with radiation were decreased hatchability and enhanced fecundity of eggs exposed to spaceflight at different stages of oogenesis. The interpretation we favor is that these two endpoints are reflections of chromosomal non-disjunction in the former case and inhibition of cell division in the latter. Our most comprehensive study of mutagenesis was on sperm, where dominant lethality, recessive lethality, translocations, and visible mutations were assayed; the only effect found was a threefold enhancement of the recessive lethal mutation frequency in the non-irradiated sperm in the orbited Habrobracon males. Behavioral and biochemical differences were found. Mating activity of orbited males was severely disrupted and xanthine dehydrogenase activity was sharply decreased in the irradiated flight animals, an unexpected observation. Postflight experiments were like the ground-based control experiments in all aspects but one. Under conditions of vibration similar to those encountered during the launch and re-entry, the mutation frequency in the sperm increased by a factor of three over that of the non-vibrated control. (auth)

41227 GAMMA RAY STERILIZATION OF PESTS. Andreev, S. V.; Martens, B. K.; Kablov, V. V. Izotopy SSSR; No. 21, 10-14 (1971). (In Russian).

The use of radiation sources for field sterilization of insect pests associated with agriculture is described. Work is discussed which was carried out at the All-Union Institute of Plant Protection, Ukrainian Institute of Plant Protection, the Grain Institute, and the State Botanical Garden VASKHNIL. (tr-auth)

41228 IMMUNIZATION BY IRRADIATED EIMERIA ACERVULINA. Ali, Nazik Abu; Binnerts, W. T.; Klimes, B. (Lebanon Animal Health Inst., Beirut). J. Protozool.; 19: No. 1, 177-80 (Feb 1972).

In 5 experiments the infectivity and immunogenicity for chickens of sporulated oocysts of Eimeria acervulina that had been previously subjected to different levels of gamma radiation were tested. It was found that the irradiation doses can be divided into three groups: High dosage levels of over 16,000 rad impair the reproduction of the parasites so that few or no oocysts are discharged and no immunity is produced. Low dosage levels of 7,000 rad and less permit reproduction and development of immunity not perceptibly different from that resulting from unirradiated oocysts. An intermediate range of levels with the optimum from 9,100–13,700 rad induced attenuation while at the same time assuring sufficient immunogenic response. A dose of 100,000 oocysts or more per bird is required to produce immunity. The optimum irradiation dose increases with the immunizing dose. It was concluded that the development of an irradiated vaccine is possible. (auth)

41229 SEGMENTAL ANEUPLOIDY AND THE GENETIC GROSS STRUCTURE OF THE DROSOPHILA GENOME. Lindsley, Dan L.; Sandler, L.; Baker, Bruce S.; (and others) (Univ. of California, San Diego, La Jolla. Univ. of Washington, Seattle). Genetics; 71: No. 1, 157-84(May 1972).

By combining elements of two Y-autosome translocations with displaced autosomal breakpoints, it is possible to produce zygotes heterozygous for a deficiency for the region between the breakpoints, and also, as a complementary product, zygotes carrying a duplication for precisely the same region. A set of Y-autosome translocations with appropriately positioned breakpoints, therefore, can in principle be used to generate a non-overlapping set of deficiencies and duplications for the entire autosomal complement. Using this method, we have succeeded in examining segmental aneuploids for 85% of chromosomes 2 and 3 in order to assess the effects of aneuploidy and to determine the number and location of dosage-sensitive loci in the Drosophila genome. Combining our data with previously reported results on the synthesis of Drosophila aneuploids (see Lindsley and Grell 1968), the following generalities emerge. The X chromosome contains no triplo-lethal loci, few or no haplo-lethal loci, at least seven Minute loci, one hyperploid-sensitive locus, and one locus that is both triplo-abnormal and haplo-abnormal. Chromosome 2 contains no triplo-lethal loci, few or no haplo-lethal loci, at least 17 Minute loci, and at least four other haplo-abnormal loci. Chromosome 3 contains one triplo-lethal locus that is also haplo-lethal, few or no other haplo-lethal loci, at least 16 Minute loci, and at least six other haplo-abnormal loci. Chromosome 4 contains no triplo-lethal loci, no haplo-lethal loci, one Minute locus, and no other haplo-abnormal loci. Thus, the Drosophila genome contains 57 loci, aneuploidy for which leads to a recognizable effect on the organism: one of these is triplo-lethal and haplo-lethal, one is triplo-abnormal and haplo-abnormal, one is hyperploid-sensitive, ten are haplo-abnormal, 41 are Minutes, and three are either haplo-lethals or Minutes. Because of the paucity of aneuploid-lethal loci, it may be concluded that the deleterious effects of aneuploidy are mostly the consequence of the additive effects of genes that are slightly sensitive to abnormal dosage. Moreover, except for the single triplo-lethal locus, the effects of hyperploidy are much less pronounced than those of the corresponding hypoploidy. (auth)

Radionuclide Effects (Internal Source)

Refer also to abstract 41033.

Man

Refer also to abstract 40616.

41230 (CONF-710201, pp 313-25) ^{90}Sr EFFECTS IN MAN. Volf, V. (Kernforschungszentrum, Karlsruhe, Ger.). Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

Luminous-dial painters in Czechoslovakia and Switzerland incorporated ^{90}Sr and ^{226}Ra body burdens that corresponded in 1966 to 10% or more of the present combined maximum permissible body burdens for both radionuclides. Data, including hematologic data and karyologic findings on peripheral blood leukocytes and bone marrow cells, are presented and discussed from the point of view of ^{90}Sr effects. Although internal irradiation from the incorporated ^{90}Sr might be an important factor in chromosomal aberrations, the effects of ^{226}Ra, external irradiation, and other factors cannot be excluded. Therefore no definite conclusions can be drawn regarding ^{90}Sr effects in man. (auth)

41231 BONE SARCOMA INCIDENCE VS. ALPHA PARTICLE DOSE. Mays, Charles W.; Lloyd, Ray D. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. pp 409-30 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

The incidence of bone sarcomas was analyzed in 12 studies involving graded internal doses of α-emitters in humans, dogs, mice, and rats. A linear dose-response relationship anchored to control incidence at zero dose was fit through each set of data over the wide dosage range extending up to, or near, the region of peak incidence. Then in the low dose regions the observed cases of bone sarcoma were compared to those from wide dose linear predictions. At low doses the observed cases were significantly fewer ($P < 0.1$) than predicted for ^{226}Ra plus ^{228}Ra in humans; for the summed studies of ^{226}Ra, ^{228}Ra, and ^{228}Th in dogs; and for ^{239}Pu in mice. However, the low dose results agree better with the indicated linear predictions than with the expected natural incidence for ^{226}Ra and ^{224}Ra in mice, and for ^{239}Pu in rats. The induction of bone sarcomas by α-emitters appears to increase linearly with dose in some cases, but to follow threshold or sigmoid relationships in others. This is in sharp contrast to the induction of bone sarcomas by β-emitters where the observed dose-response over a wide dosage range was non-linear in every known case. (auth)

41232 RADIOGENIC EFFECTS IN MAN OF LONG-TERM SKELETAL ALPHA-IRRADIATION. Evans, Robley D. (Massachusetts Inst. of Tech., Cambridge); Keane, Albert T.; Shanahan, Mary Margaret. Contract AT(30-1)-952. pp 431-68 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

In the absence of human-injury data, some radiation protection guides for ^{239}Pu, ^{90}Sr, and other bone-seeking radionuclides are founded on the human radium base-line or reference standard of 0.1 μCi Ra residual burden, combined with radionuclide toxicity ratios determined from observations on long-lived experimental animals. In the M.I.T. series of human long-term radium cases, from a presently identified population of about 2200 individuals, some 600 have so far been studied (1970) while living plus, about 60 after death through autopsy specimens, exhumations, or willed bodies, in addition to 120 matched control individuals. At average skeletal cumulative dosages above about 1000 rads marked radiobiological effects are seen. Among the epidemiologically suitable (unselected) high-dose cases the cumulative incidence of bone sarcomas plus head carcinomas is about 0.28. The tumor appearance time in humans seems to increase with decreasing dosage, as it does in beagles, such that there would be a domain of dosages for which the required tumor appearance time exceeds the life span, thus defining a practical threshold dosage. In more than 500 individuals with doses below about 1000 rads no radiogenic tumors or significant skeletal effects are seen and there is no discernible life-span shortening. No smooth analytical function has been found which gives a close fit to our response-vs.-dosage data for unselected cases over the entire range of dosage. In humans undergoing long-term skeletal α-irradiation there is evidence for recovery processes and dose-rate dependence. Life-long observations are required before the response-vs.-dosage relationships are certainly the final values. For a significant fraction of the radium and mesothorium subjects the life span will extend beyond the year 2000. Vigorous and long-term efforts will be exerted by the AEC's Center for Human Radiobiology to obtain the maximum information from this unique, inadvertently exposed, and irreplaceable human population. (TSS)

41233 CUMULATIVE RADIATION EFFECT. PART II. CONTINUOUS RADIATION THERAPY: LONG-LIVED SOURCES. Kirk, J.; Gray, W. M.; Watson, E. R. (Western Regional Hospital Board, Glasgow. Western Infirmary, Glasgow). Clin. Radiol.; 23: No. 1, 93-105(Jan 1972).

In a previous paper, a scale of accumulated sub-tolerance radiation damage, the Cumulative Radiation Effect (CRE), was described for fractionated regimes. This scale provides a means of assessing and comparing the biological effects of varied treatment regimes. In this paper, the concept of the CRE is extended to include an equivalent scale of damage to normal connective tissue for continuous radiation of constant dose rate (a particular case of a more general application of the CRE to time-varying continuous radiation to be introduced in a following paper). The properties of the CRE function for continuous radiation are discussed in some detail, and its application to various clinical situations described and illustrated by examples. The CRE approach is made applicable to a variety of sources by considering the relative biological effectiveness of the radiation. The generality of the definition of the CRE for all forms of radiation treatment strategy has been assured by normalizing the CRE for continuous radiation to that for fractionated treatment regimes achieving the same biological effect. The equivalence conditions existing at the junctions between schedules are considered. A knowledge of these conditions is essential since the effect of additional radiation damage cannot be evaluated without taking into consideration the CRE already achieved. A derivation is given of the approximate correction factor to be applied to implants and insertions to adjust the treatment time for dose rates different from those intended; this value of the correction differs to some extent from that currently used. (auth)

41234 RADIATION DOSIMETRY ASSOCIATED WITH THE INTRATHECAL ADMINISTRATION OF ^{131}I HUMAN SERUM ALBUMIN. Johnston, R. F.; Staab, E. V.; Brill, A. B.; Allen, J. H. (Vanderbilt Univ., Nashville. Veterans Administration Hospitals, Nashville). Brit. J. Radiol.; 45: No. 534, 444-51(Jun 1972).

A study was made of the radiation dose to the spinal cord from intrathecal administration of ^{131}I-IHSA. In this study digital scan images of the activity in the cerebro-spinal fluid (CSF) were collected from patients undergoing cisternographic procedures. From the data, time retention curves were obtained and corrections made for surrounding blood activity. Estimates of the absorbed dose to the spinal cord and nerve roots were made, using the experimental measurements in conjunction with concentric cylinder target-source geometry for the β radiation. Uncertainties involved in the dose estimation are discussed. Final values of the absorbed dose at the injection site are 16 ± 8 rads to the spinal cord and 19 ± 9 rads to the nerve roots for an administered activity of 100 μCi ^{131}I-IHSA. (auth)

Animals

Refer also to abstract 41284.

41235 (CONF-710201) BIOMEDICAL IMPLICATIONS OF RADIOSTRONTIUM EXPOSURE. Proceedings of a Symposium held at Davis, California, February 22–24, 1971. AEC Symposium Series 25. Goldman, Marvin; Bustad, Leo K. (eds.) (California Univ., Davis. Radiobiology Lab. Atomic Energy Commission, Washington, D. C.). Apr 1972. 411p. Dep. NTIS.

Separate abstracts were prepared for the 23 papers presented at this symposium. (C.H.)

For abstracts of individual papers see: 41161, 41230, 41236–41249, 41265–41268, and 41276–41278.

41236 (CONF-710201, pp 1-16) PROCEEDINGS SYNTHESIS. Goldman, Marvin; Bustad, Leo K. (Univ. of California, Davis). Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

Significant facts and opinions regarding the biomedical implications of radiostrontium exposure are summarized. Concern about radiostrontium originally arose because of its potential hazard as a component of fallout from nuclear weapons testing. Interest stemmed from the high fission yield of ^{90}Sr, its long half-life (28 years), its persistence in the biosphere, and its long-term retention in man. As a result of atmospheric testing through 1962, 20 MCi of ^{90}Sr was produced from the total 200 Mt of fission yield. Since that time, another megacurie of ^{90}Sr has been produced. By 1970 the stratospheric inventory showed about 0.35 MCi of ^{90}Sr, only 5% of which was from the earlier test period. Stratospheric depositions are transferred to the ground with a half-life of about 10 months. Although global deposition patterns are greatly influenced by the locations of the test areas, deposition in each hemisphere tends to be higher in the mid-latitudes, and the major portion of strontium deposition on earth occurs in the spring and summer. The major site of strontium absorption in man is probably the upper small intestine. Data are summarized from studies on ^{90}Sr metabolism and internal radiation effects in animals. The validity of animal data for evaluation of the risk to man is discussed. (C.H.)

41237 (CONF-710201, pp 103-13) RADIATION DOSE TO BEAGLES FROM CONTINUOUS ^{90}Sr EXPOSURE. **Goldman, Marvin; Della Rosa, R. J.; Momeni, M. H. (Univ. of California, Davis).** Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

The body burden achieved by 1.5 years of continuous feeding of ^{90}Sr−^{90}Y to beagles can be rapidly determined by counting the bremsstrahlung intensity and, if applied to skeletal mass estimation, this body burden can be used to calculate average skeletal dose. In beagles the estimate is 0.5 rad per microcurie of ^{90}Sr fed per day and ranges from 0.02 to 20 rads/day in the dose levels under study. With deposition from either acute labeling or at very young ages, the effects of the lower bone density of the deposition sites do not introduce more than a 20% underestimation of ^{90}Sr−^{90}Y relative to the bremsstrahlung intensity from compact bone. Local ^{90}Sr−^{90}Y doses to cells within bone vary with the spatial geometry of the radionuclide within the mineral and range from 0.2 to 0.8 of the dose to mineral bone if it is uniformly labeled. The location of cells at risk is postulated to be analogous to the distribution of red marrow. After a uniform labeling of the mineral, these cells may receive lower dose rates owing to the tenfold more rapid rate of local bone turnover. The compact bone of the beagle appears to lose its ^{90}Sr with a half-period of about 15 years. Cellular dosimetry in terms of effects, such as neutropenia, tumor site, and time of appearance at high dose rates, suggests that the cells at risk are not spatially and temporally constant. Application of appropriate nuclear medicine technology to determine the location of injury and repair, when combined with local dose values, may provide a rad-per-cell estimate that is spatially and temporally defined and is of use in assessing risk. (auth)

41238 (CONF-710201, pp 114-29) RADIATION DOSES TO ^{90}Sr-FED SWINE. **Palmer, R. F.; Thomas, J. M.; Watson, C. R.; Beamer, J. L. (Battelle Memorial Inst., Richland, Wash.).** Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

Gompertz growth curves were fitted to data for both skeletal growth and skeletal accumulation of ^{90}Sr in miniature swine ingesting 1 to 125 μCi of ^{90}Sr per day from birth to nearly 8 years of age. Normalized ^{90}Sr-accumulation data from the animals ingesting 1, 5, or 25 μCi/day were adequately described by a single equation. Data from animals ingesting 125 μCi/day, however, required a different equation to reflect increased absorption and/or retention of ^{90}Sr that was apparently due to radiation damage. Derived equations expressing ^{90}Sr concentration in skeleton vs age peaked at about 9 months of age and then decreased to a plateau. This finding was associated with the fact that the ^{90}Sr content of the skeleton reached a plateau earlier in life than did skeletal weight. Utilization of the equations and appropriate factors permitted calculation of the cumulative ionizing radiation dose delivered to bone over the lifetime of the animals. A complementary study, conducted to better define the radiation dose to fetuses of these animals, showed that during the second half of gestation the fetuses were irradiated from their own deposits of ^{90}Sr−^{90}Y and not significantly from the ^{90}Sr−^{90}Y of their dam. (auth)

41239 (CONF-710201, pp 149-67) TOXICITY OF INHALED RADIOSTRONTIUM IN EXPERIMENTAL ANIMALS. **McClellan, R. O.; Boecker, B. B.; Jones, R. K.; Barnes, J. E.; Chiffelle, T. L.; Hobbs, C. H.; Redman, H. C. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).** Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

A summary is presented of the retention, tissue distribution, dosimetry, and biologic effects of inhaled ^{90}Sr in mice, rats, and beagle dogs. These aspects were found to be dependent upon the form of the radiostrontium inhaled. Relatively soluble forms are rapidly absorbed from the respiratory and gastrointestinal tracts and translocated to skeleton. The effects are similar to those observed following acute oral or intravenous intake: early deaths related to hematopoietic damage and later deaths due to neoplasms of bone and contiguous tissues. Relatively insoluble radiostrontium deposited in lung is retained with a biological half-time measured in hundreds of days and is slowly translocated to tracheobronchial lymph nodes and skeleton. That deposited in the upper respiratory tract is cleared rapidly via the gastrointestinal tract. The relative radiation dose to turbinates, lung, gastrointestinal tract, tracheobronchial lymph nodes, and skeleton is a function of the solubility and size distribution of the aerosol inhaled. With relatively insoluble ^{90}Sr at high levels of initial lung activity, early deaths have been related to pulmonary fibrosis and pneumonitis; later deaths attributed to pulmonary neoplasia are predicted. (auth)

41240 (CONF-710201, pp 168-81) AGE, STRAIN, AND DOSE-RATE EFFECTS OF ^{89}Sr IN MICE. **Wright, James F. (Bureau of Radiological Health, Rockville, Md.); Goldman, Marvin; Bustad, Leo K.** Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

Mice of three inbred strains were studied to 14 months of age for effects caused by continuous ingestion of ^{89}Sr for 180 days. Findings were recorded on differences in survival rate and induction of hematopoietic and bone tumors to determine the effects of strain, age sensitivity, dose level, and sex differences. Animals were fed a diet containing either 20 or 60 μCi of ^{89}Sr per gram of calcium in the feed, beginning either at conception or at weaning. Incidence of hematopoietic neoplasms, chiefly thymic lymphomas, was highest in the RFM strain at highest dose levels. Bone tumors were evident in the BALB/c and C57BL strains, occurring most frequently in the femur and tibia at highest dose levels. Survival rate followed an inverse relation to dose level in all three strains. The survival rate was lowest in the RFM strain, as a result of a high incidence of lymphomas, and in the C57BL strain, because of a high incident of bone tumors. Differences in age sensitivity were not apparent at the age of 14 months. (auth)

41241 (CONF-710201, pp 182-206) BIOEFFECTS OF CONTINUOUS SHORT-TERM EXPOSURE OF FELINES TO RADIOACTIVE STRONTIUM: PRELIMINARY REPORT. **Nelson, N. S.; Berman, E.; Rosenstein, L. S.; Ward, J. M.; Wright, James F. (Environmental Protection Agency, Rockville, Md.).** Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

For a determination of the relative radiosensitivity of cats during different periods of development, weanling and adolescent cats were studied after oral administration of ^{89}Sr for 30 days at one of four dose levels: 100, 50, 25, or 0 μCi of ^{89}Sr per day. In the acute phase, during dosing, all of the cats at 100 μCi/day and 16% at 50 μCi/day died. There were no deaths among the other weanlings or adolescent cats. Some parameters in the hemograms showed early and pronounced graded depression. Segmented neutrophils in weanling cats showed the earliest response: within 7 days at the 100 μCi/day level, 11 days at 50 μCi/day, and 15 days at 25 μCi/day. The adolescents showed similar but less-rapid responses. In the weanling groups, segmented neutrophils reached their minimum values during the dosing period, less than 1% of the sham value for the 100 μCi/day level and 2% for the 50 μCi/day level. The depression of the platelets occurred later but was similar in magnitude. Red-cell parameters showed no significant changes except in terminal stages. By day 150 all irradiated weanlings except two at 25 μCi/day had died, and all but two adolescent cats had survived. Neutrophil recovery was commensurate with the magnitude of the insult. The 100 μCi/day adolescents remained 90% below sham values at the end of the post-dose period, while the 25 μCi/day adolescents were within normal ranges. Platelets behaved similarly. Lymphocytes were depressed 20 to 60% from the sham values, but the response was too erratic to be related to the dose level. The red-cell values were depressed by 40% in the 100 μCi/day adolescents at about day 60 after dosing but were within normal range by the end of the observation period. Clinical symptoms were characteristic of the radiation-induced hemorrhagic syndrome, with minor hemorrhages in various tissues. Free bleeding into large body cavities or gross evidence of bleeding from the gastrointestinal tract was not apparent. The bone marrow of cats exposed to the higher dose levels was aplastic. Marrow from cats exposed to lower levels was cellular and composed primarily of erythropoietic cells with few granulocytic cells and megakaryocytes. Myelofibrosis was seen in five cats, and myeloid metaplasia, usually in the lymph nodes, developed in five cats, one case resembling granulocytic leukemia. Ultrastructural studies of bone marrow revealed degenerative changes in mitochondria of plasma cells. Viral particles were not found in the marrow samples of the four cats studied. (auth)

41242 (CONF-710201, pp 207-41) ^{90}Sr-INDUCED MALIGNANCIES IN MICE. **Nilsson, Agnar (Research Inst. of National Defence, Sundbyberg, Sweden).** Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

Results are summarized from a series of investigations in which different doses of ^{90}Sr per gram of body weight were administered to young adult mice by intraperitoneal injection for study of carcinogenic action in bone tissue, mucous membranes of the head, and hematopoietic tissue and equal doses of ^{90}Sr were administered to mice whose internal metabolism was changed by gestation and lactation, BCG treatment, and estrogen administration. The highest frequency of carcinomas occurred in the group given 1.6-μCi of ^{90}Sr/g body weight; osteosarcomas were most numerous in the 0.8-μCi group. Doses from 0.2 to 0.4 μCi gave the highest inci-

dence of leukemia. In bone tissue both tumor incidence and induction time were dose dependent, with the time becoming shorter as the dose increased. In the 0.8-μCi group, most tumors were localized in the long tubular bones, particularly in the femur. In the 1.6-μCi group, the most frequent site was in the spine and pelvic bones, and only a few tumors were found in the femur. In the 1.6- and 0.8-μCi groups, about 70% of the tumors were osteoblastic osteosarcomas, 20 to 25% were fibroblastic osteosarcomas, and the others were angiosarcomas. In contrast, about 70% of the 0.4-μCi group were fibroblastic osteosarcomas. The rate at which early tumor buds were transformed into microtumors or overt osteosarcomas of the predominantly fibroblastic type were significantly enhanced by increasing the dose. This was not true, however, with osteosarcomas of the osteoblastic type. The tumor transplantation studies revealed that the osteoblastic osteosarcomas might be more antigenic than tumors of the fibroblastic type. When equal doses of ^{90}Sr were given to unmated mice and to mated mice that were allowed to give suck to a number of consecutive litters, the number of bone tumors among the mated mice was less by a factor of 2 than among unmated mice. The survival time for mated mice was significantly greater, as was the tumor-induction time of 399 ± 11 days as compared with 312 ± 4 days for the unmated mice. A very significant shift in the pattern of tumor location was observed. In the unmated group, for example, 112, or 17.9%, of the tumors were localized in the sacral and lumbar vertebrae. The corresponding value for the mated group was 8, or 2.3%. Among the ^{90}Sr-injected and BCG-infected mice, there were significantly fewer tumor-bearing mice than among mice not infected with BCG. Differences in survival time were minor: 317 ± 7.0 days for infected mice and 306 ± 6.5 days for uninfected mice. (auth)

41243 (CONF-710201, pp 242-58) ^{90}Sr EFFECTS IN SWINE: A SUMMARY TO DATE. Clarke, W. J.; Busch, R. H.; Hackett, P. L.; Howard, E. B.; Frazier, M. E.; McClanahan, B. J.; Ragan, H. A.; Vogt, G. S. (Battelle Memorial Inst., Richland, Wash.). Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

Experiments involving the ingestion of 1 to 3100 μCi of ^{90}Sr per day by nearly 800 female miniature swine, extending over three generations, showed that there were no significant differences in the litter size, the percentage of stillborn, or the birth weight between control animals and animals ingesting up to 625 μCi/day. Animals on 3100 μCi/day did not survive the gestation period. There have been 70 cases of hematopoietic disorders in these animals: 55 in the F$_1$ and F$_2$ offspring and 15 in the original dams. Of these cases 41 have been neoplastic and 29 have been metaplastic. Of approximately 200 untreated female littermate controls, only two developed hematopoietic neoplasms. Bone tumors have been seen in seven F$_1$ and F$_2$ offspring but only in groups receiving either 125 or 625 μCi of ^{90}Sr per day. It is evident that ^{90}Sr feeding levels high enough to affect fetal or neonatal mortality of swine will not permit maternal survival long enough for the bearing of young. It is also readily apparent that the primary response of miniature swine to the chronic ingestion of ^{90}Sr is manifested as leukemogenic effects on bone marrow and the lymphoreticular systems and not as tumorigenic effects on bone. (auth)

41244 (CONF-710201, pp 259-76) ^{90}Sr TOXICITY IN ADULT BEAGLES AFTER ACUTE EXPOSURE. Dougherty, Jean H.; Taylor, G. N.; Mays, Charles W. (Univ. of Utah, Salt Lake City). Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

Seven injection levels of ^{90}Sr ranging from 0.6 to 98 μCi/kg were studied in 87 adult beagles, 34 of which were still alive on Jan. 20, 1971. An acute hematological syndrome appeared at 2 to 5 weeks postinjection; late changes appeared at 900 to 2000 days. The late effects included eleven bone sarcomas, one carcinoma of the frontal sinus, and three hematological fatalities with severe progressive anemia, all of which occurred at 64 or 98 μCi of ^{90}Sr per kilogram. The three hematological fatalities are described in detail. Lesser but definite injury to the hematopoietic organs occurred at dose levels of 11 and 33 μCi ^{90}Sr/kg. At or below 11 μCi/kg, there have been no deaths positively attributable to ^{90}Sr. Hematopoietic neoplasms have not yet been observed. (auth)

41245 (CONF-710201, pp 277-84) ^{90}Sr TOXICITY IN ADULT BEAGLES AFTER CONTINUOUS INGESTION. Pool, R. R.; Williams, R. Jean Romer; Goldman, Marvin (Univ. of California, Davis). Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

The effects of ^{90}Sr are being studied in 373 adult beagles that were given the radionuclide in their feed at seven levels ranging from 0.03 to 36 μCi/day from conception to 540 days of age. Hematologic effects have already been reported. Irregular linear osteolytic fibrotic lesions are frequently found in the compact bone of dogs fed the highest level after they have acquired a cumulative radiation dose greater than 8000 rads. Neoplastic transformation in some areas of cortical repair indicates that at least some of the strontium-induced sarcomas arise in sites of repair in the diaphyseal cortex of long bones and in the compacta of the mandible. The tumors involving bone after chronic ^{90}Sr ingestion in 19 beagles include 21 sarcomas (14 macroscopic osteosarcomas, three microscopic osteosarcomas, two fibrosarcomas, one hemangiosarcoma, and one chrondrosarcoma), four squamous cell carcinomas, and one chloroma. Only the two highest levels of ^{90}Sr have been effective in producing osteosarcomas in beagles. The largest number of sarcomas, predominantly osteosarcomas of the limbs, has appeared in the highest dose level. The next two levels have produced tumors only in the head. Bone tumors other than fibrosarcomas have been seen only after accumulation of a mean skeletal dose of ~8000 rads. The two maxillary fibrosarcomas occurred after a cumulative dose >3700 rads. (auth)

41246 (CONF-710201, pp 285-312) ^{90}Sr TOXICITY IN DOGS: STATUS OF ARGONNE STUDY ON INFLUENCE OF AGE AND DOSAGE PATTERN. Finkel, Miriam P.; Biskis, Birute O.; Greco, Isabel; Camden, R. W. (Argonne National Lab., Ill.). Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

Strontium-90 was given to dogs of different ages and in different dosage patterns to obtain data that might be useful in predicting toxicity in man. The experiment is still in progress; current results are summarized. Animals received ^{90}Sr either in a single injection or in a series of fractional injections for one year; others were treated in utero by the injection of ^{90}Sr into their dams. The LD$_{50/30}$ for a single injection in adult dogs was estimated to be 150 μCi/kg. No life-span shortening effect is yet apparent at dosages of 10 to 15 μCi/kg given after birth or 7 to 41 μCi/kg given before birth. Malignant bone tumors attributable to ^{90}Sr are osteosarcoma, hemangiosarcoma, and fibrosarcoma. Many of these tumors were induced by 150 μCi/kg, but none have appeared so far after a single injection of 10 to 100 μCi/kg or in animals born with body burden of 7 to 41 μCi kg. (auth)

41247 (CONF-710201, pp 326-33) ANOMALOUS EFFECTS IN ^{90}Sr-TREATED RAT EMBRYOS. Hopkins, B. J. H. (Univ. of Rochester, N. Y.). Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

Strontium-90 produced both lethal effects and morphological changes in the developing rat embryo following single intravenous injection into pregnant dams. A dose of 382 μCi of ^{90}Sr administered intravenously to pregnant dams on day 2 postconception produced a 57.6% incidence of mortality in offspring by day 20 postconception. A total of 18.3% of the survivors showed gross morphologic defects. The mortality incidence was low, 5.5%, but the incidence of anomalies was comparatively high, 47.9%, when injection was done on day 10 postconception. Effects were associated with an average absorbed dose to the embryo ranging from a high of approximately 12.0 rads/day near the time of injection to approximately 0.3 rad/day on day 3 posttreatment. The response of the rat embryo to the effects of ^{90}Sr was qualitatively similar to the response reported for external radiation. A possible mode for radioembryologic changes in vertebrate embryos is briefly described. (auth)

41248 (CONF-710201, pp 345-51) DETERMINATION OF CUMULATIVE TUMOR INCIDENCES AND THEIR USE IN QUANTITATIVE EVALUATION OF RADIONUCLIDE CARCINOGENESIS. Rosenblatt, L. S. (Univ. of California, Davis). Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

A model is described for estimating the age-specific tumor incidence rates and cumulative incidence to any given time or age for mammals following the administration of a given dose of radioisotope. The four relationships postulated are as follows: the effect (cumulative tumor incidence) within each dose group is related to time by the logistic equation and may be interpreted by the Stover–Eyring technique; with time held constant, effects are related to the log of the dose by the logistic equation; and it is thus possible to estimate the effect of a given dose at a given time; maximum incidence is related to the log of the dose by the logistic equation; and for a given cumulative incidence, the times at which these incidences occur are related to the log of the dose by the logistic equation. (C.H.)

41249 (CONF-710201, pp 352-75) BONE SARCOMA RISK FROM ^{90}Sr. Mays, Charles W.; Lloyd, Ray D. (Univ. of Utah, Salt Lake City). Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

The incidence of bone sarcomas was analyzed in five experiments involving graded doses of ^{90}Sr in mice, rats, dogs, and pigs. The incidences at low doses were consistently less than those predicted from linear dose–response relations that started at control values and were fit through all dosage groups up to the region of peak incidence. Although linearity is not supported over a wide dose range, the low-dose data can be fit very well by either practical threshold relations or by sigmoid relations, indicating that beta irradiation at sufficiently low dose rates is not highly effective in the induction of bone sarcomas. The calculated cumulative 50-year risk to human adults for average skeletal doses below 1000 rads from ^{90}Sr is below the upper limit of 4.5 cases of bone sarcoma per million person rads. Our present best estimates of the actual 50-year risks below 1000 rads from ^{90}Sr are 1 ± 1 sarcomas/10^6 person rads for a low dose linear model and 4 ± 4 sarcomas/10^{10} person rads^2 for a dose-squared model. These estimates are based on observations of the radium-dial painters and the toxicity of ^{90}Sr relative to ^{226}Ra in mice and dogs. Evidence in humans, mice, dogs, and pigs indicates that the young (children) may be one-half to four times as sensitive as adults to the induction of bone sarcomas. The risk from ^{90}Sr-induced leukemia was not estimated, but, at least for children, it could well exceed the risk from bone sarcoma. (auth)

41250 (COO-119-244, pp 117-25) EARLY HEMATOLOGIC EFFECTS OF CALIFORNIUM IN THE BEAGLE. Dougherty, Jean H. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1971.

In Research in radiobiology.

The hematologic changes following intravenous injection of ^{249}Cf or ^{252}Cf into 11 young adult beagles are reported for the first 8 weeks post-injection. Three dogs that received approximately 2.8 μCi/kg of ^{249}Cf developed a severe depression of granular leukocytes and platelets that was maximal 2 to 3 weeks following injection with little recovery by 8 weeks. The lymphocytes were decreased below normal by 2 weeks and continued to fall thereafter to one-third of pre-injection values. Changes in granular leukocyte values on four dogs injected with approximately 0.28 μCi/kg of ^{249}Cf were compared to those of four dogs injected with approximately 0.28 μCi/kg of ^{252}Cf. There was a greater and more prolonged depression in the ^{252}Cf-injected dogs probably due to the added bone dose rate from fission fragments on bone surfaces that would cause a greater irradiation of bone marrow. There have been no changes thus far in red cells, platelets, or lymphocytes in dogs receiving 0.28 μCi/kg of either ^{249}Cf or ^{252}Cf. (auth)

41251 (COO-119-244, pp 250-69) ELECTRON MICROSCOPY OF RADIATION DAMAGE IN BONE. Whitson, William S.; Jee, Webster S. S. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1971.

In Research in radiobiology.

Some morphological effects of radionuclides on bone are described that were observed with the use of the electron microscope. Haversian canal and osteocytic lacunar fibrosis, perivascular cell reduction, and osteolysis and subsequent osteostasis are present. Endothelial vacuolization increases with dosage level. Kidney failure led to an increase in the number of osteoclasts and fusion between osteoclasts and adjacent cells was found. (auth)

41252 (COO-119-244, pp 402-24) COMPARATIVE EFFECTS OF ^{239}Pu AND ^{241}Am ON BIOCHEMICAL PARAMETERS: EFFECTS OF DOSE AND RADIONUCLIDE BURDEN TIME. Nabors, Charles J. Jr.; Stevens, Walter; Maxwell, Richard E. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1971.

In Research in radiobiology.

A comparison of the effects of ^{239}Pu and ^{241}Am on serum biochemical parameters was made using the technique of multiple regression analysis. A separate analysis was made of data from male and female animals with plutonium animals also being separated into tumor and non-tumor groups. Two major differences were evident: ^{241}Am appears to produce significant changes in SGPT and serum alkaline phosphatase at earlier times post-injection than ^{239}Pu; male beagle dogs appear to be more susceptible to radiation induced changes in SGPT, SGOT, and serum alkaline phosphatase than females. The significance of these findings and their possible relationship to carcinogenesis and hormonal effects are discussed. (auth)

41253 RADIOBIOLOGY OF PLUTONIUM. Stover, Betsy J.; Jee, Webster S. S. (eds.). Salt Lake City; J. W. Press (1972). 583p. $17.50.

Separate abstracts were prepared on the 25 chapters included. (C.H.)

For abstracts of individual chapters see: 41172, 41231, 41232, 41254–41262, 41270, 41271, and 41293–41303.

41254 GENERAL SYNDROME INDUCED BY ^{239}Pu IN THE BEAGLE. Taylor, Glenn N.; Christensen, William R.; Shabestari, Lorraine; Jee, Webster S. S. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. pp 59-74 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

The most critical factors in the toxicity syndrome induced in dogs by a single I.V. injection of tetravalent ^{239}Pu were the induction of bone cancer, hematopoietic changes, and liver lesions. Some of the less serious end points were pathological fractures, dental changes, and atrophy of the turbinates. These latter conditions produced functional impairment in only part of the dogs and principally at the higher dose levels. In the soft tissues, moderate thyroid atrophy and very focal kidney degeneration were induced by the 2.9 μCi ^{239}Pu/kg dose, but neither of these changes was detectable clinically. An increased incidence of soft tissue neoplasia was also noted in the irradiated groups, but this was not unequivocally established as a ^{239}Pu-induced factor. (auth)

41255 HEMATOLOGIC CHANGES INDUCED BY ^{239}Pu IN BEAGLES. Dougherty, Jean H. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. pp 75-86 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

The hematologic changes following a single intravenous injection of a wide range of doses of ^{239}Pu (0.016 to 2.8 μCi/kg) in young adult beagles have been followed over the lifespan of the animals. This study has been underway for 20 years. All of the dogs in the original 12 injection groups have died, the main cause of death being osteosarcoma. Blood cell alterations were found in dogs receiving the four highest dose levels. The changes were dose-dependent and were most marked in granular leukocytes which were maximally depressed at 2 to 3 weeks post-injection. A sustained lymphopenia occurred at the two highest dose levels. A transient early thrombocytopenia and anemia were also found in higher level dogs. A moderate anemia reappeared as the animals became terminal. There was myeloid metaplasia in spleens and livers of dogs at autopsy. The hematologic changes found after ^{239}Pu injection were compared to several other internal emitters (^{228}Ra, ^{228}Th, ^{228}Ra and ^{90}Sr). The bone-surface seekers, ^{239}Pu and ^{228}Th, were found to be the most damaging to the hematopoietic system. (auth)

41256 COMPARATIVE EFFECTS OF ^{239}Pu AND ^{241}Am ON BIOCHEMICAL PARAMETERS: EFFECT OF DOSE AND RADIONUCLIDE BURDEN TIME. Nabors, Charles J. Jr.; Stevens, Walter; Maxwell, Richard E. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. pp 87-103 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

A comparison of the effects of ^{239}Pu and ^{241}Am on serum biochemical parameters of dogs has been made using the technique of multiple regression analysis. A separate analysis was made of data from male and female animals with plutonium animals also being separated into tumor and non-tumor groups. Two major differences were evident: ^{241}Am appears to produce significant changes in SGPT and serum alkaline phosphatase at earlier times post-injection than ^{239}Pu; male beagle dogs appear to be more susceptible to radiation-induced changes in SGPT, SGOT and serum alkaline phosphatase than females. The significance of these findings and their possible relationship to carcinogenesis and hormonal effects is discussed. (auth)

41257 HEPATIC CHANGES INDUCED BY ^{239}Pu. Taylor, Glenn N.; Jee, Webster S. S.; Williams, Jerry L.; Shabestari, Lorraine (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. pp 105-27 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

For several hundred days following a single intravenous injection of tetravalent ^{239}Pu in dogs, most of the liver burden was retained in the hepatic cells, but ultimately a high percentage shifted into the liver reticulo-endothelial cells. The rate of translocation was greatest in the highest levels. The liver lesions thus induced consisted principally of hepatic cell necrosis followed by regenerative changes. Restoration of the lost cells was sufficient to maintain normal liver weights except in a few of the dogs injected at the highest level (~2.9 μCi ^{229}Pu/kg). Significant regenerative changes were produced at injected doses extending down to 0.0168 μCi ^{239}Pu/kg and at average cumulative liver doses of less than 80 rads. Studies at still lower levels are in progress, but the relatively short latent periods presently preclude evaluation. Intrahepatic bile duct tumors were observed in 10 percent of the ^{239}Pu-injected dogs surviving beyond 1000 days of age; however, most of these were small benign growths which were found incidentally at autopsy. Only twenty percent of the tumors were fatal malignancies. The incidence of bile duct neoplasms in the ^{239}Pu-injected dogs was 2½ times that of the controls, and all of the primary liver malignancies occurred in the ^{239}Pu groups. Other forms of primary liver neoplasia were not observed. (auth)

41258 ^{241}Am IN BEAGLES: BIOLOGICAL EFFECTS AND SKELETAL DISTRIBUTION. Lloyd, Ray D.; Jee, Webster S. S.; Atherton, David R.; Taylor, Glenn N.; Mays, Charles W. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. pp 141-8 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

Injected ^{241}Am deposits on bone surfaces within the skeleton. No important differences were observed in the gross whole bone distribution of ^{241}Am compared with ^{239}Pu in beagles injected with citrate-complexed Am III or Pu IV. However, autoradiography revealed that the initial distribution of ^{241}Am upon bone surfaces was more uniform than that of ^{239}Pu. For ^{239}Pu, the deposits on endosteal and trabecular surfaces were about 2 to 4 times greater than on the periosteal surfaces. For ^{241}Am, they were only about 1.5 to 2 times greater than the periosteal deposits. Biological damage from ^{241}Am in beagles was observed in all 4 tissues of highest activity concentration: liver, thyroid, skeleton, and kidney. (auth)

41259 DISTRIBUTION OF INTERNAL RADIATION-INDUCED OSTEOGENIC SARCOMA IN VARIOUS SPECIES. Christensen, William R.; Jee, Webster S. S.; Taylor, Glenn N.; Nebeker, Ned (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. pp 195-211 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

The localization of osteogenic sarcoma varies markedly from species to species, whether occurring as a spontaneous tumor or as a result of an internally-deposited, bone-seeking radionuclide. In humans the spontaneous tumors show an unusual predilection for the region of the knee joint. ^{226}Ra-induced tumors in humans are located primarily in the appendicular skeleton (90%), but there are relatively few at the knee joint. The most common site is the pelvis. In dogs 60% of the radiation-induced tumors are found in the appendicular skeleton, whereas in mice only 25% of such tumors are so located. The most common site in the mouse is the vertebral column. In the case of both dogs and mice the distributions of ^{239}Pu- and ^{226}Ra-induced osteogenic sarcoma are quite dissimilar. (auth)

41260 SOME SPECULATIVE EXTENSIONS TO MAN OF ANIMAL RISK DATA ON PLUTONIUM. Thompson, Roy C.; Park, James F.; Bair, William J. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. pp 221-30 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

Speculative extensions of the available animal risk data to the problem of plutonium oxide inhalation by man suggest that, regardless of the model employed for prediction, the risk of lung tumors is not greatly different from the risk of liver tumors, and both lung and liver tumors are somewhat more likely than bone tumors. Absolute numerical predictions of the tumor incidence to be expected from a permissible deposition of plutonium oxide in the lung vary with the model employed for prediction and little reliance can be placed on these numbers. The more conservative approaches, however, lead to predictions of total tumor incidence of a few percent from an initial lung deposit of 0.04 μCi, which is a higher number than one would wish to see associated with a permissible deposition. (auth)

41261 VASCULAR THEORY OF RADIATION INJURY TO BONE. Park, Han Z.; Whitson, S. William; Jee, Webster S. S. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. pp 305-22 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

The morphology of the contents of the haversian canals of cortical bone of old controls and internal α irradiation-injured dogs was examined by electron microscopy. Tight junctions are found between mesenchymal cells, preosteoblasts, and osteoblasts. This functional syncytium is postulated to be involved with coordinating the activities of cells, facilitating transport between cells and/or forming an extracellular space/bone barrier. Other findings include processes of pericytes juxtaposed to processes of perivascular cells and osteoblasts and osteocytes containing centrioles and microtubules. The order of decreasing radiosensitivity for cells in the haversian canal is endothelial cells, mesenchymal cells, and osteoblasts. Irradiation-induced changes in endothelial cells include decreased numbers of pinocytotic vesicles, vacuolization, thickened and ragged basement membrane, increased numbers of inclusion particles, and blistering. Changes in perivascular cells include diminution in numbers of cells and increased lysozomal-like inclusions in the cells. Fibrosis is observed in the perivascular space. These changes are related to our working hypothesis of radiation-induced alterations in the transport of ions and molecules between blood and bone. (auth)

41262 EFFECTS OF ^{239}Pu AND RELATED RADIONUCLIDES ON SURVIVAL OF THE ADULT BEAGLES. Stover, Betsy J. (Univ. of North Carolina, Chapel Hill. Univ. of Utah, Salt Lake City); Eyring, Henry; Atherton, David R. Contract No. AT(11-1)-119. pp 385-407 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

Survival data for groups of dogs at six dose levels of ^{239}Pu or ^{226}Ra are compared with survival data from a group of protected controls. Each nuclide was given in a single intravenous injection of a 0.08 M citrate buffer solution of pH 3.5. Each control dog was injected with an approximately equal volume of the buffer. Over a range of five dose levels of ^{239}Pu, survival times increased as the dose level decreased. At the lowest of the six dose levels there was no life-shortening relative to the controls. However, the occurrence of osteosarcoma, which is induced by ^{239}Pu, greatly exceeded the occurrence in the controls even at this lowest dose level. In the case of ^{226}Ra, progressive life-shortening was observed at the three higher dose levels, but at the three lower levels there was little life-shortening. Osteosarcomas were observed at all but the lowest dose level. The degree of life-shortening at high dose levels was similar for both radionuclides, but this similarity was not observed at the lower levels. (auth)

Plants

41263 EFFECTS OF BETA RADIATION ON WHEAT, PEAS, AND LETTUCE EXPOSED BY FOLIAR CONTAMINATION WITH WATER-SOLUBLE ^{90}Y. Schulz, R. K.; Baldar, N. (Univ. of California, Berkeley). Radiat. Bot.; 12: No. 2, 77-85(May 1972).

Young Romaine lettuce, Ramona 50 wheat, and dwarf pea plants were contaminated with ^{90}Y by brief immersion of the foliage in solutions containing various concentrations of ^{90}Y. The contaminated crops were then grown for periods of from one to three months and yields noted. The grain production and seed viability of the wheat were reduced 50% when the foliage was contaminated with ^{90}Y at the rate of about 3 μCi/cm^2. Pea pod production was reduced 50% when the ^{90}Y was deposited on the foliage at about 4 μCi/cm^2. But the yield of lettuce was not reduced as much as 50%, even when ^{90}Y was applied in the highest amounts (37 μCi/cm^2). When a contaminant level of 10 μCi/cm^2 was reached, abnormalities in lettuce growth were clearly visible. (auth) (UK)

Nuclide Kinetics and Toxicology

Refer also to abstracts 40586 and 40830.

41264 ^{90}Sr CONTAMINATION OF MILK AND FOOD SAMPLES IN INDIA. Lalit, B. Y.; Subba, Rao, M.; Hingorani, S. B. (Bhabha Atomic Research Centre, Bombay). Health Phys.; 23: No. 1, 47-54(Jul 1972).

The levels of ^{90}Sr in milk from Bombay and 27 other places in India and in samples of composite diet from Bombay for the period 1962 – 1968 are reported. The levels of ^{90}Sr in these samples reached peak values during 1963 – 1964 and are since then declining. The results show that the concentration of ^{90}Sr in milk normalized to unit rainfall increases with latitude. The results are discussed in relation to the rate of fallout, seasonal variation and other meteorological phenomena. (UK)

Man

Refer also to abstract 41253.

41265 (CONF-710201, pp 17-30) GLOBAL ^{90}Sr FALLOUT AND ITS OCCURRENCE IN DIET AND MAN. Bennett, Burton G. (Atomic Energy Commission, New York). Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

Measurements of global ^{90}Sr fallout and its levels in food and man have been made by the Health and Safety Laboratory, U. S. Atomic Energy Commission, since 1954 to determine the behavior of ^{90}Sr in the environment and in man. About 13 MCi of ^{90}Sr, produced in weapons testing, have been accounted for in deposition. The Northern Hemisphere has received about three times more deposition than the Southern Hemisphere, but the current deposition rates are about equal. The present stratospheric inventory of ^{90}Sr is estimated to be about 0.35 MCi. Quarterly sampling of representative diet items in New York, Chicago, and San Francisco illustrates the changes that occur in the total ^{90}Sr intake and in the relative contributions of the various food categories. Current intakes of 5 to 15 pCi/day have declined from maximums of 15 to 40 pCi/day in 1963 to 1964. The ^{90}Sr levels in human bone have declined from maximums of 1.2 to 2.1 pCi/day in 1965 to 0.9

to 1.7 pCi/day in 1969 in San Francisco and New York, respectively. The variations have been reasonably well described by one- and two-compartment exponential models. The global variation of ^{90}Sr body burdens is not closely correlated with cumulative ^{90}Sr fallout but must instead be related more directly to actual diet levels. (auth)

41266 (CONF-710201, pp 31-51) METABOLISM AND REMOVAL OF RADIOSTRONTIUM IN MAN. Spencer, Herta; Kramer, Lois; Samachson, Joseph (Veterans Administration Hospital, Hines, Ill.). Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

The pathways of excretion of intravenously and orally administered ^{85}Sr, the factors that influence its absorption and retention in the body, and the compounds that affect its removal in man are described. Excretion of ^{85}Sr given intravenously and orally is mainly via the kidney. During low calcium intake, only an average of 20% of the orally administered ^{85}Sr is absorbed. Increasing the calcium intake about 10-fold did not consistently or significantly decrease this absorption; adding phosphate to either a low or a high calcium diet moderately decreased radiostrontium absorption. Stable strontium, vitamin D, lactose, and lysine did not affect the absorption of ^{85}Sr. Parathyroid extract (PTE) had no effect on the absorption of ^{85}Sr, but the functional state of the thyroid influenced absorption strikingly; i.e., there was a marked increase following the correction of hyperthyroidism and of induced hypermetabolism. Aluminum phosphate gel markedly inhibited the intestinal absorption of ^{85}Sr, the effect being greatest when this compound was given immediately prior to the oral dose of ^{85}Sr. The absence or presence of food markedly affects the absorption of radioactive strontium in man. In the absence of food, absorption is increased by a factor of 2 to 3 compared with the absorption of the tracer ingested with food. Studies of ^{90}Sr balance showed that the net absorption of ^{90}Sr averaged 15% and that stable calcium did not significantly decrease this absorption. (auth)

41267 (CONF-710201, pp 68-84) MODEL OF STRONTIUM METABOLISM IN ADULT MAN. Marshall, John H. (Argonne National Lab., Ill.). Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

The power-function model has been extended to provide ^{90}Sr retention functions for both compact and cancellous bone, bone surfaces, soft tissue, blood plasma, and the whole body of men. The new model associates the final exponential in whole-body retention with the mechanism of apposition–resorption in compact bone. Data for ^{90}Sr in both cancellous bone and total skeleton due to fallout from 1953 to 1970 are included. (TSS)

41268 (CONF-710201, pp 95-102) RADIOSTRONTIUM AVAILABILITY AND METABOLISM: REMARKS. Comar, C. L. (Cornell Univ., Ithaca, N. Y.). Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

The possibility of ^{89}Sr and ^{90}Sr being released to the environment during reactor accidents is discussed. The value of data obtained from fallout studies and laboratory studies using animals in evaluating the potential hazards from peacetime use of nuclear energy is stressed. It is pointed out that the 1957 Windscale reactor accident, in which a fire occurred in a graphite reactor, released 20,000 Ci of ^{131}I, 2 Ci of ^{90}Sr, and 80 Ci of ^{89}Sr to the environment, but that reactors have many safety devices in their design so that the chance of a significant release of radioactivity is remote. Most future reactor accidents are expected to be far less serious than the Windscale accident. If there is a release of ^{90}Sr from a reactor accident, the amount will be small because of its low volatility. The initial hazard to man will be from inhalation from a cloud of radioactive material. The best protective measure would be the evacuation of the population during the few hours required for the passage of the radioactive cloud. Ingestion hazards could be controlled by importing uncontaminated foods. (C.H.)

41269 (CONF-710840-1) NUCLEAR RADIATION AND HUMAN HEALTH. Sternglass, E. J. (Pittsburgh Univ., Pa.). 1970. 101p.

From International conference on pollution control; Trondheim, Norway (26 Aug 1971).

The effects of radioactive fallout from nuclear weapons testing on human health during the last 25 years are discussed. It is suggested that large scale statistical studies and experimental investigation of fission product effects on the human endocrine sytem should be carried out before energy generation by nuclear fission is irreversibly decided. (TSS)

41270 PLUTONIUM IN MAN: A NEW LOOK AT THE OLD DATA. Durbin, Patricia W. (Univ. of California, Berkeley). pp 469-530 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

In order to determine the relationships between urinary Pu excretion and body Pu content, 18 persons (15 over the age of 45) were injected in 1945 and 1946 with tracer doses of ^{239}Pu. The original data are critically reviewed and re-analyzed. A few days after injection, human soft tissues (other than blood and liver) contained as much as 20% of the Pu dose. Five to 15 months after injection the average liver Pu content was 31% of the dose for three cases with presumably normal liver function. Four to 457 days after injection mean total skeletal Pu was 49% for the seven cases judged to have most nearly normal livers and skeletons. Pu is transported in blood combined with transferrin, the iron-transport protein, and is stored in the liver in association with stored iron. After being bound to transferrin, Pu partially traces the behavior of the carrier protein. The early phases of Pu transport which are apparently associated with extra-cellular fluid mixing, were prolonged in individuals with impaired circulation. Maximum urinary Pu excretion occurred before the bulk of Pu was protein-bound. Minimum urinary excretion coincided with the time of maximum Pu-transferrin binding. Fecal excretion of Pu apparently represents excretion in bile and other digestive juices. (TSS)

41271 U. S. TRANSURANIUM REGISTRY: PROGRESS AND EXPECTATIONS. Norwood, William D. (Hanford Environmental Health Foundation, Richland, Wash.). pp 531-7 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

The United States Transuranium Registry (National Plutonium Registry) was established in 1968 to provide a record of the exposure of personnel to transuranium elements. The registry collects, codes, analyzes, and data processes material on the health and health physics aspects of present and past exposed employees during life and compares these data with pathological, bioassay, and mortality findings after death. (C.H.)

41272 IODINE CONTENT OF THYROID GLANDS OF NORMAL JAPANESE. Yamagata, N. (Inst. of Public Health, Tokyo); Yamagata, T. J. Radiat. Res.; 13: No. 2, 81-90(Jun 1972).

Thyroid glands obtained from instantaneous victims in Tokyo during the period from September to December 1962, when the fallout rate was the highest, were analyzed for the stable iodine. The average concentration was twice as much as the ICRP data (4×10^{-4} g/g), namely, 0.85 mg/g fresh tissue, ranging from 0.45 to 2.48. The dietary intakes of iodine by Japanese people are suggested as about 300 μg on the average with a basic diet containing a minimum of seaweed and incidental consumption of seaweed may lead to a maximum of 10 mg intake. No significant correlation was found between the levels of ^{131}I and stable iodine in the thyroids in this period, probably due to a wide variation of ^{131}I intake among people. The use of ICRP data for Japanese will give a conservative estimate in the exposure calculation. (auth)

41273 ABSORBED DOSE IN THE LUNGS CAUSED BY RADIOACTIVE AEROSOLS. Zalmanzon, Yu. E.; Chumkin, O. A. Med. Radiol.; 17: No. 4, 63-8(Apr 1972). (In Russian).

The radiation lung burden is discussed as a function of the degree of dispersal of an inhaled radioactive aerosol. The radioactive particle size distribution is treated in relation to the limits encountered in actual practice, and also considered in the light of international recommendations. It is demonstrated that for a given concentration of ^{239}Pu in the form of an aerosol, the dose absorbed by the human lungs may vary by a factor of 100. (tr-auth).

41274 CONSIDERATION OF THE RADIATION DOSE FOLLOWING INTERNAL CONTAMINATION WITH ^{131}I. Clemente, G. F. (CSN-Casaccia, Rome). Minerva Fisiconucl.; 15: No. 4, 177-84(Oct-Dec 1971). (In Italian).

Data obtained from whole-body counting performed on four subjects internally contaminated with ^{131}I for medical purposes are reported. The subjects examined had, when measured, internal contaminations greater than 20 μCi. In three of these persons, the biological $T_{1/2}$ of ^{131}I could be determined and the values obtained range between 94 and 118.5 days. In one of the subjects the fecal and urinary excretions were followed up for about three months. If the first 24 hr period is excluded, the fecal excretion to urinary excretion ratio is constant at approximately 0.1. In all the subjects, the dose both to the thyroid and to the whole-body was calculated. The thyroid doses were particularly high, ranging between 142 and 1030 rem. On the basis of these results some suggestions are given to prevent the occurrence of doses of the levels observed and to better consider the doses due to diagnostic examinations through the administration of radioactive substances. (auth)

41275 FREQUENCY DEPENDENCE OF INTRAPULMONARY DISTRIBUTION OF ^{133}Xe IN SMOKERS. Martin, R. R.; Anthonisen, N. R. (Royal Victoria Hospital, Montreal). Union Med. Can.; 101: No. 4, 652-5(Apr 1972). (In French).

Early detection of obstructive pulmonary disease necessitates techniques capable of evaluating the function of small airways but ideally should be simple for both patient and investigator. The alveolar plateau—gas concentration plotted against expiratory volume during a single expiration represents the intrapulmonary distribution of gas prior to expiration; in normal lungs this distribution should be only slightly dependent on the speed of the previous inspiration. In small airways disease, however, gas distribution is dependent on inspiratory flow rates. In such subjects, the alveolar plateau might depend on the speed of the previous inspiration. Normal subjects were administered boli of ^{133}Xe at about 50% of vital capacity. They inhaled the boli either very slowly or with maximal speed. Subsequent alveolar plateaux were examined and were found to depend relatively little on the speed of bolus inhalation. Fifty heavy smokers, of different ages and total amount of cigarettes smoked, were then studied and their results were compared to those in normals. In addition other lung function tests were performed including residual volume, airway resistance and frequency dependence of compliance. Abnormalities were common with frequency dependence of compliance and of the alveolar plateau being the most common. The results of these tests correlated well. It is concluded that this technique was superior to residual volume or airways resistance measurement to detect abnormalities. Finally, while similar abnormalities were found when compared to results from frequency dependence of compliance, the Xenon technique proved faster and easier for the subjects. (auth) (Canada)

Animals

Refer also to abstract 41235.

41276 (CONF-710201, pp 52-67) APPLICATION OF CANINE METABOLIC DATA TO MAN. Della Rosa, R. J.; Goldman, Marvin; Wolf, H. G.; Rosenblatt, L. S. (Univ. of California, Davis). Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

Metabolic factors associated with uniform labeling of skeletons of beagles that were fed ^{90}Sr from midgestation to 1.5 years of age are summarized. The placental and mammary barriers reduced ^{90}Sr concentration in young pups. The radionuclide concentration in bone changed rapidly with consumption of the diet containing ^{90}Sr. At adulthood the ^{90}Sr/Ca ratio in the labeled skeleton was 0.4 that in the diet. The levels ranged from 0.03 to 36 μCi of ^{90}Sr per day. The loss of uniform label is seen as a decrease in the ^{90}Sr/Ca ratio with time postfeeding. The loss was most rapid in sternum and/or trabecular bone corings and slowest in cortical bone. The half-period for trabecular bone was ~2.2 years; that for cortical bone ~15 years. Time courses of ^{90}Sr activity in plasma and total excreta were fitted to a sum of three exponentials. The half-periods for the longest (third) component were ~2.7 years for urine and plasma and 4 to 5 years for feces; the first and second half-periods were a few days and ~0.5 years, respectively. The ^{90}Sr concentrations in soft tissues with time postfeeding depend upon their turnover rates and the rates of mobilization of early skeletal deposits of ^{90}Sr. At body burdens up to 400 μCi of ^{90}Sr (~20 rads/day to the skeleton) one year postfeeding, the plasma and soft tissue concentrations were ~40 pCi ^{90}Sr/g; calculated doses to soft tissue, including gonads, were ~2 mrads/day in animals at extremely high risk for radiation-induced bone and bone-marrow tumors. The ^{90}Sr concentration in semen was about 0.1 that in plasma, with nearly all the detectable activity in the seminal plasma. The sperm of these animals were consistently less motile than those of animals receiving lower levels of ^{90}Sr. A comparison of metabolic dynamics of strontium and calcium in dog and man indicates an intake rate 20 times greater and an absorption rate 6 times greater in the dog per kilogram of body weight. The strontium excretion rate via urine and endogenous feces of the dog is much greater than that of man, but per unit of body weight the resultant concentration in plasma, exchangeable pool, and bone is twice that of man. (auth)

41277 (CONF-710201, pp 85-94) FACTORS IN ^{90}Sr AND ^{90}Y DOSES TO THE GONADS AND OTHER SOFT TISSUES. Brues, A. M. (Argonne National Lab., Ill.). Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

The distribution of ^{90}Sr and ^{90}Y in tissues of dogs, mice, and rats is discussed in relation to the β dose to gonads and other soft tissues as a function of time following ingestion or intramuscular injection. Concentrations in soft tissues generally paralleled those in plasma, but usually at lower levels. In young, growing animals, the active compartment of bone removed Sr from the plasma-soft tissue compartment and rapidly sequestered it. Strontium was also removed from the plasma-soft tissue compartment by excretion, the rate depending on the size of the animal, with the rate slower in larger animals. (C.H.)

41278 (CONF-710201, pp 334-44) EFFECTS OF RADIOSTRONTIUM ON PUPPY MORTALITY AND LITTER SIZE IN DOGS. Rosenblatt, L. S.; Bielfelt, S. W.; Della Rosa, R. J. (Univ. of California, Davis). Apr 1972.

From Biomedical implications of radiostrontium exposure conference; Davis, Calif. (22 Feb 1971).

The experimental design used in radiostrontium and ^{90}Sr studies permitted detailed analyses of puppy mortality. Female beagles, as they came into season, were randomly mated to unrelated males. Each of the 12 males was mated to a minimum of 18 females, with one litter assigned to a ^{90}Sr dose level. There were two runs using six males each. Puppy mortality was not different in the two runs, and the 12-sire families were combined into a single population. For neonatal mortality (0 to 3 days) and mortality to weaning (0 to 42 days), there were no significant differences between sire families, indicating that the additive genetic components, and hence the heritabilities, were approximately zero. The standard errors about the sire means were very large, owing to the large variations of dam means about the sire means, which may be attributed to differences in maternal abilities. Similarly, differences between the several dose levels receiving ^{90}Sr and the controls were not statistically significant, nor did there appear to be a dose-dependent trend. In another experiment using a feeding level (36 μCi of ^{90}Sr per day) three times higher than the highest level used in the main study, four dams produced two litters each. Puppy mortality was less than half that observed in the large study, even though the dams had a substantial body burden (100 to 150 μCi) of ^{90}Sr at the time they conceived their second litters. Two litters were produced by matings of dogs that had received 36 μCi ^{90}Sr/day beginning in utero. Mortality of the pups was in the normal range, and the surviving pups were normal. In all of these studies, ^{90}Sr had no effect on the number of pups whelped, and it may be presumed that there was also no effect on embryonic or fetal mortality. (auth)

41279 (COO-119-244) RESEARCH IN RADIOBIOLOGY. Annual Report of Work in Progress in the Internal Irradiation Program. Dougherty, Thomas F. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1971. Contract AT(11-1)-119. 422p. Dep. NTIS.

Separate abstracts were prepared for 16 of the 21 papers appearing in this report. The other five papers discuss the effects of glucocorticoid and parathyroid hormone on bone remodeling, activity relationship of corticosteroids to growing bones, kidney function in aging beagles, genetics of canine blood group A, and a non-linear interpretation to the doubling dose concept. Six abstracts of papers presented at various symposia are included. Injection tables for animal radioisotope toxicity studies are also presented. (E.R.B.)

For abstracts of individual papers see: 41250–41252, 41280–41290, 41315, and 41316.

41280 (COO-119-244, pp 102-16) CALIFORNIUM RETENTION, EXCRETION, AND DISTRIBUTION IN BEAGLES SOON AFTER INJECTION. Lloyd, Ray D.; Mays, Charles W.; Atherton, David R.; Taylor, Glenn N.; Williams, Jerry L. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1971.

In Research in radiobiology.

The metabolism of californium was studied in 11 beagles from 0 to 82 days after intravenous injection with ^{247}Cf or ^{252}Cf as Cf (III) in citrate buffer. Total excretion during the first 21 days after injection was mainly urinary. Of the Cf eliminated in this 3-week period, about $^3/_5$ appeared in the first day's collection. Nearly twice as much californium was excreted in 3 weeks after injection as was observed with beagles given ^{241}Am or ^{239}Pu. A combination of total-body and partial-body gamma-ray counting of the living dogs indicated that at 1 week about 20% of the injected Cf was deposited in the liver and that nearly 60% remained in non-liver tissue (mainly skeleton). This retention pattern persisted until at least 82 days after injection. In contrast, the retention of ^{241}Am during a corresponding period averaged about 50% of the injected activity in liver and 40% in skeleton, while values for ^{239}Pu averaged about 30% in liver and 60% in skeleton. Two dogs were sacrificed for distribution studies 7 and 21 days after the injection of ^{249}Cf. Tissues exhibiting relatively high Cf concentrations were liver, skeleton, kidney, dura, connective tissue, and, in the 7 day dog, the thyroid. Although liver concentration of Cf was lower relative to that of ^{239}Pu or especially ^{241}Am, kidney concentration of Cf was significantly higher. Skeleton Cf concentration was similar to that for ^{239}Pu but was about double that for ^{241}Am at corresponding burden times. Average thyroid concentrations of these three elements were highest for americium and californium but lowest for plutonium. Tissues at risk from incorporated californium appear to be liver, skeleton, kidney, and thyroid. (auth)

41281 (COO–119-244, pp 126-46) DISTRIBUTION OF ^{249}Cf AND ^{249}Bk IN THE SOFT TISSUES OF BEAGLES. Taylor, G. N.; Jee, W. S. S.; Dell, R. B.; Mays, C. W.; Williams, J. L.; Shabistari, L. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1971.
In Research in radiobiology.

The microscopic distribution pattern of ^{249}Cf and ^{249}Bk in the soft tissues of beagles, at one to three weeks following a single intravenous injection of a citrate solution, was very similar to ^{241}Am. Relatively high concentrations occurred in the hepatic cells of the liver, the glomeruli of the kidney, the interfollicular region of the thyroid, the cartilaginous tissues of the lung, and media of the smaller arterioles of most organs. Very intense, but sparsely scattered hot spots were also present in the renal papillae and in the submucosa of the bronchioles. Lesser sites of localization were the endocardium of the AV heart valves, the glassy membranes of the larger hairs of the coat, the zona pellucida of the Graafian follicles and the zona arcuata of the adrenal cortex. With the exception of the liver, where the radionuclide was principally within the hepatic cells, most of the deposition sites were extracellular, within or adjacent to connective tissue that gave a positive periodic acid-Schiff reaction. (auth)

41282 (COO–119-244, pp 151-8) DISTRIBUTION OF INJECTED ^{241}Am IN THE BEAGLE SKELETON. Lloyd, R. D.; Atherton, D. R.; Gaufin, Susan S.; Mays, C. W. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1971.
In Research in radiobiology.

The distribution of ^{241}Am in the skeletons of 10 beagles injected with 0.31 to 4.53 μCi/kg at 1 to 1533 days prior to sacrifice was determined by gamma-ray counting. Comparison of percent retained skeletal ^{241}Am values with percent skeletal ash values for each bone or bone group showed that bones containing much trabecular bone had a higher ratio of skeletal Am to skeletal ash than the average for the the total skeleton, while bones containing much cortical bone had a lower ratio than the skeletal average. (auth)

41283 (COO–119-244, pp 159-74) SUBCELLULAR DISTRIBUTION OF ^{241}Am(III) AND ^{239}Pu(IV) IN LIVERS STUDIED SERIALLY. Stevens, W.; Bruenger, F. W.; Atherton, D. R.; Stover, Betsy J. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1971.
In Research in radiobiology.

Two beagles were injected with 2.67 μCi of ^{241}AmIII and 2.77 μCi of ^{239}PuIV/kg respectively. Liver specimens were obtained by serial surgical biopsies. Samples were homogenized, subjected to differential and sucrose density gradient centrifugation. Specific enzyme markers were used for locating mitochondria and lysosomes. The density distribution of these organelles in the dog did not allow a clear separation of these particles. At short times after injection, both nuclides were associated mostly with soluble liver proteins (ferritin). Later, increasing quantities migrated into the mitochondrial-lysosomal fraction. The rate of redistribution was faster for plutonium than for americium. In the dog injected with plutonium, the percent dose in the cytosol changed from 44% to 3% and the percent dose in the mitochondrial-lysosomal fraction from 28% to 62% during a period of 70 days. Gradient separation of 6,000 g-min supernatants showed a shift in the americium content of heavy fractions from 3% to 50% and a concomitant shift from 76% to 29% in the light fractions during the same period. The respective values for plutonium are 8% to 32% in the heavy fraction and 66% to 21% in the light fraction during a period of 30 days with a second redistribution at time ≥30 days. On the basis of protein concentration, the highest concentration of both nuclides was associated with fractions of high acid phosphatase activity, but no linear relationship between acid phosphatase and total radioactivity was observed. (auth)

41284 (COO–119-244, pp 176-210) EARLY SKELETAL DISTRIBUTION AND RETENTION OF ^{239}Pu(IV) AT AN INTERMEDIATE AND LOW DOSE LEVEL IN THE BEAGLE. Stover, Betsy J.; Atherton, David R.; Buster, Dawn S. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1971.
In Research in radiobiology.

Four dogs were injected intravenously with 0.30 μCi ^{239}Pu/kg and twelve with 0.016 μCi ^{239}Pu/kg and sacrificed at times ranging from 5 to 769 days after injection. Tetravalent, non-colloidal plutonium in about 9 ml 0.08 M citrate buffer solution of pH 3.5 was given in each case. Representative portions of all parts of the skeleton (except the sacrum) were analyzed for ^{239}Pu. Both the amount and the concentration in wet bone were measured so that total skeletal retention and average radiation dose rate for a particular bone could be estimated. The calculated skeletal retention is given by $B = 48.9\ e^{-0.00050t}$ for $t < 1000$ds which is not valid beyond about 1000 days. To illustrate the variation in skeletal deposition and retention from dog to dog and also bone to bone, data for each of the 16 are presented in this report. (auth)

41285 (COO–119-244, pp 212-27) INTERACTION BETWEEN BLOOD CONSTITUENTS AND SOME ACTINIDES. Bruenger, F. W.; Atherton, D. R.; Stevens, W.; Stover, Betsy J. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1971.
In Research in radiobiology.

The interaction of a number of actinide elements with constituents of canine and human blood was studied and compared to extensive, already existing data on ^{239}PuIV and ^{241}AmIII in beagles. ^{228}Th, ^{233}Pa, ^{233}U, ^{237}Np, and ^{249}Cf were used for these experiments. The nuclides in 0.08 M citrate buffer were incubated in vitro with canine and/or human blood. None of the nuclides had a marked affinity for blood cells. High and low molecular weight components of plasma were separated by gel chromatography on Sephadex G-25 and amounts of nuclide associated with each fraction were evaluated. Binding to plasma proteins was further evaluated by gel chromatography on resins of low cross linkage and by anion exchange chromatography. Nuclides forming strong complexes with inorganic constituents of plasma showed only limited binding to protein constituents. The pH-ranges of protein complex stabilities were determined in some cases by difference spectrophotometry. (auth)

41286 (COO–119-244, pp 228-39) ACCUMULATION OF MACROPHAGES LABELLED WITH ^{239}Pu IN MARROW SPACES OF LUMBAR VERTEBRAL BODIES. Jee, Webster S. S. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1971.
In Research in radiobiology.

Labeled macrophages are generated when osteoclasts progressively concentrate plutonium after resorption of bone surfaces labeled with plutonium, and when subsequently the macrophages engulf the dead osteoclasts that contain the plutonium or bind the plutonium freed by the disintegrating osteoclast. The efflux of labeled macrophages occurs when live, dead, or fragmented macrophages laden with plutonium are swept out of the marrow into the circulation. The accumulation of labeled macrophages is an indicator of altered kinetics of both macrophages and bone cells. Labeled macrophages are observed in beagles injected with 2.7, 0.9, 0.3, 0.09, and 0.05 μCi ^{239}Pu/kg, but not in 0.015 μCi ^{239}Pu/kg dogs at death (4 to 6 yrs post-injection). Optimal accumulation of labeled macrophages appears in the 0.05 μCi ^{239}Pu/kg injected dogs. At the lowest dose level (0.015 μCi/kg injected), there is peak labeling at $^1/_4$ to 2 yrs post-injection and no evidence of labeled cells at post-injection times greater than 4 yrs. Despite the accumulation of labeled macrophages, there is a paucity of death due to hematopoietic changes and hematopoietic neoplasms in the dogs. These dogs died mostly of osteosarcoma death. (auth)

41287 (COO–119-244, pp 240-9) HIGH RESOLUTION NEUTRON-INDUCED AUTORADIOGRAPHY OF BONE CONTAINING ^{239}Pu. Jee, W. S. S.; Miller, L. G.; Dell, R. B. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1971.
In Research in radiobiology.

The detailed neutron-induced autoradiographic process for bones containing plutonium-239 produced autoradiographs with both fission fragment tracks and a corresponding bone image. Seven microns thick undecalcified bone sections were apposed on 300 microns thick Lexan (polycarbonate) film and exposed to neutrons in the thermal column of the Material Testing Reactor (MTR) at the National Reactor Testing Station in Idaho. The specimens were immersed in 28% KOH at 50°C for one hour to etch pinholes at the location of each fission track and pitting of the film at the location of the bone. The film, when inspected microscopically, exhibited both fission fragment tracks and a corresponding bone image. When the films were etched immediately after irradiation, no bone image was produced. When the bone sections were allowed to remain on the film for several weeks after irradiation, the bone caused a pitting of the film surface. Betas from ^{32}P seemed to be the main charged particles available to produce the pitting. This detailed neutron-induced autoradiographic process has advantages over the nuclear emulsion autoradiography of bones because it eliminated long exposure times and fading of latent image. (auth)

41288 (COO–119-244, pp 270-83) AUTORADIOGRAPHIC STUDY OF THE EARLY DISTRIBUTION OF ^{45}Ca IN ALVEOLAR BONE OF DOGS. Jee, W. W. S.; Dell, Rebecca B.; Davis, M. A. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1971.
In Research in radiobiology.

An autoradiographic study designed to yield information about the prompt uptake of ^{45}Ca in alveolar bones of adult mongrels at 2 and 30 hrs after injection of ^{45}Ca found the greatest darkening at alveolar bone surfaces located at or near the alveolar crest and at forming bone surfaces of trabeculae and forming osteons. The next greatest darkening is seen at cemental and the remaining alveolar bone surfaces. Haversian canals of formed osteons of intermediate mineralization are poorly labeled with ^{45}Ca. Our findings suggest that the greatest exchange of calcium between bone and blood takes place at the bone surfaces with the richest blood supply (i.e. alveolar crest and areas of bone formation). (auth)

41289 (COO-119-244, pp 284-90) EFFECT OF CORTISOL ON BONE ACCRETION, ^{45}Ca EFFLUX, AND TRABECULAR BONE RESORPTION. Park, H. Z.; Jee, K. W.; Jee, W. S. S. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1971.

In Research in radiobiology.

In dose response studies using 0, 0.5, 1, 5, 20, and 75 mg of cortisol/kg/day for 7 days in 100 g rats, a significant reduction in tibial metaphyseal bone volume was measured in male rats injected with 1 and 5 mg of cortisol/kg/day. Female rats did not show such change. Endochondral growth of male rats measured by tetracycline labeling (25 mg/kg body weight) showed that there was significant inhibition of bone growth at dose levels of 20 and 75 mg of cortisol/kg/day. Decreased efflux of deep store ^{45}Ca was observed at day 3 of treatment with doses of 0.5, 5, and 20 mg of cortisol/kg/day. At day 6, the differences of efflux among these three dose levels became insignificant. (auth)

41290 (COO-119-244, pp 376-88) ASSOCIATION OF ^{210}Pb WITH CONSTITUENTS OF ERYTHROCYTES. Bruenger, F. W.; Stevens, W.; Stover, Betsy J. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1971.

In Research in radiobiology.

The interaction of trace amounts of lead with constituents of blood was investigated. In vivo experiments using ^{210}Pb were performed in beagles and in vitro studies were done with human and canine whole blood or isolated blood cells. At low concentrations of lead, about 90% of the nuclide found with red cells was associated with red cell cytoplasm and less than 10% was bound to stroma. Transfer of Pb across the red cell membranes did not require binding of the nuclide to plasma proteins. Red cell cytoplasm analyzed by electrophoresis showed that most of the lead was found in the hemoglobin containing fractions. In the dog, varying amounts were also found in fractions with an electrophoretic mobility greater than hemoglobin. The HbA$_2$ ($\alpha_2\delta_2$) component of human erythrocytes had a much higher affinity for ^{210}Pb than the main HbA ($\alpha_2\beta_2$) fraction. Only after saturation of the HbA$_2$ fraction were greater quantities of lead found in the main hemoglobin band. Lead also was bound to erythrocuprein. (auth)

41291 (NVO-269-8(Rev.1)) RADIOLOGICAL RESURVEY OF ANIMALS, SOILS, AND GROUNDWATER AT BIKINI ATOLL, 1969-1970. Held, Edward E. (Washington Univ., Seattle. Lab. of Radiation Ecology). Feb 1971. Contract AT(26-1)-269. 44p. Dep. NTIS.

The results of radiometric and radiochemical analyses of samples, exclusive of land plants, collected at Bikini Atoll in 1969 and 1970 are presented and discussed. Average values in pCi/g wet for radionuclides in food items collected in 1969 were: reef fish, ^{60}Co 2.6, ^{90}Sr .08, ^{137}Cs .13; pelagic fish, ^{60}Co .94, spiny lobster, ^{60}Co .12; giant clams, ^{60}Co 24; curlews, ^{60}Co .94, ^{137}Cs 380; turnstones, ^{60}Co 7.7, ^{137}Cs 56; and terns, ^{60}Co 1.1, ^{137}Cs .08. Average concentrations of ^{90}Sr in the muscle of coconut crabs from Bikini and Eneu Islands were 12 pCi/g wet and .05 pCi/g wet, respectively. There are no striking differences between average values for edible foods of marine origin, including the sea birds, compared with values reported in 1967. Predominant radionuclides in undisturbed soils in 1969 are ^{55}Fe, ^{60}Co, ^{65}Zn, ^{90}Sr, ^{125}Sb, ^{137}Cs, and ^{207}Bi. In the crater sediments ^{55}Fe, ^{60}Co, ^{90}Sr, and ^{207}Bi predominate. There are quantitative and qualitative differences in radionuclide content associated with the feeding habit of fish and there appears to be an increasing concentration of some radionuclides with increasing age of fish and clams. The radionuclide content of bird species presents a sharp contrast, both qualitatively and quantitatively, associated with feeding habit. It appears that some ^{60}Co and ^{207}Bi is being transported eastward by the bottom current in the lagoon. Silver-108m, previously unreported in fallout, was found in the hepatopancreas of the spiny lobster. Tritium levels in groundwater are within the range of values for continental surface water samples. The present levels of radionuclides and their distribution at Bikini are not likely to change significantly except for decrease in amounts, due to physical decay. (auth)

41292 (SWRHL-110-r) RADIONUCLIDE CONCENTRATIONS AND BOTANICAL COMPOSITION OF THE DIET OF CATTLE GRAZING THE AREA 18 RANGE OF THE NEVADA TEST SITE, 1966-1970. Smith, D. D.; Brown, K. W.; Brechbill, R. A.; Giles, K. R.; Lesperance, A. L. (Western Environmental Research Lab., Las Vegas, Nev.). May 1972. 38p. Dep. NTIS.

The radionuclide content and botanical composition of the diet of the beef animals grazing on the Area 18 range of the Nevada Test Site was determined by analyzing rumen samples collected from fistulated steers. The radionuclide concentrations were generally low with periodic increases in individual isotope levels which could be traced to a specific contaminating event. The content of ^{144}Ce, ^{137}Cs, ^{131}I, ^{239}Pu, ^{106}Ru, ^{95}Zr, and ^{65}Zn in rumen samples was measured. Grass exceeded 80% of the diet of 23 out of 43 monthly samples. Squirrel tail grass, Sitanion hystrix and Indian rice grass, Orhyzopsis hymenoides, were the major components of this portion of the diet. The major browse plants ingested were Gambel's Oak, Quercus gambelii, and desert bitter brush, Purshia glandulosa. Russian thistle, Salsola kali, and desert buckwheat, Eriogonum spp. were the main contributors to the forb portion of the diet. At times during the summer months Russian thistle constituted over 30% of the total diet. (auth)

41293 CHEMICAL ASSOCIATIONS OF ^{239}Pu(IV) AND ^{241}Am(III) IN BLOOD, LIVER, AND THYROID. Stover, Betsy J. (Univ. of North Carolina, Chapel Hill. Univ. of Utah, Salt Lake City); Stevens, Walter; Bruenger, Friedrich W. Contract AT(11-1)-119. pp 129-40 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

Plutonium, as ^{239}Pu(IV) in 0.08 M citrate buffer of pH 3.5, was given by intravenous injection to young adult beagles. Following injection the concentration of plutonium in blood decreased slowly, since a large but variable fraction of the plutonium formed a complex with transferrin, the iron transport protein. The Pu(IV)-transferrin complex was sufficiently stable to be separated from other serum constituents. The formation of Pu(IV)-transferrin was blocked by Fe(III) and Pu(IV) was displaced from the complex by Fe(III). The Pu(IV)-transferrin association was reversed by citrate at pH 7.5. Some plutonium deposits in most tissues, but the principal sites of deposition are in the skeleton and the liver. Hepatic retention of plutonium decreased slowly with time at all dose levels, but the rate of decrease was greater at higher levels where there is marked destruction of hepatic cells. At the subcellular level in the liver, significant concentrations of plutonium were observed in nuclear, mitochondrial, and microsomal fractions, in the cytosol, and also in connective tissue. In the cytosol most of the plutonium occurred in association with ferritin, the iron storage protein. It was also found in association with lipofuscin and with an unidentified material of molecular weight of about 1500. The association of plutonium with ferritin is highly stable. The probable mechanism by which Pu(IV)-ferritin is eliminated from the liver is through death of the hepatic cell followed by phagocytosis by RE cells and subsequent localization in the portal regions. In contrast, americium, ^{241}Am(III), injected in the same buffer, was cleared rapidly from the blood. Am(III) does form complexes in the blood with both transferrin and albumin, but they are less stable under physiological conditions than the complexes of plutonium. The skeleton and liver are also the principal deposition sites for americium, and the rate of decrease of hepatic retention increases with increasing dose level because of destruction of cells. Significant concentrations of americium were found in the several subcellular fractions of the liver. In comparison with plutonium, relatively more americium was found in the hepatic cytosol, in association with ferritin, lipofuscin, and a material of low molecular weight. The relative amount of americium found in the low molecular weight fraction was greater than in the case of plutonium. Significant concentrations of americium were found in the connective tissue of the thyroid. (auth)

41294 RETENTION OF ^{239}Pu(IV) IN THE BEAGLE. Stover, Betsy J. (Univ. of North Carolina, Chapel Hill. Univ. of Utah, Salt Lake City); Atherton, David R.; Buster, Dawn S. Contract AT(11-1)-119. pp 149-69 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

The retention and distribution of plutonium in the skeletons of beagles injected with 0.016 μCi ^{239}Pu/kg have been measured over the interval of 5 to 769 days. The retentions in the humerus and third lumbar vertebra were measured in dogs injected with 0.016, 0.048, and 0.095 μCi/kg. These dogs survived approximately 1600 to 5200 days after injection. The combined data show that the rate of decrease of retention is greater during the first two years than at later times. These data can be described by a sum of two exponentials. The early period corresponds to a period of more rapid bone remodelling. Determination of approximate skeletal retention in one dog at 4375 days after injection confirmed the two phases of decrease in retention for the entire skeleton. The skeletal retention is combined with hepatic retention to obtain total retention for dose levels 0.016 to 0.095 μCi/kg. Prior results on skeletal retention obtained at higher dose levels are compared with the results at low dose levels and are found to be higher. This is consistent with the observed decrease in bone remodelling at high dose levels. (auth)

41295 ^{239}Pu IN BONES AS VISUALIZED BY PHOTOGRAPHIC AND NEUTRON-INDUCED AUTORADIOGRAPHY. Jee, Webster S. S. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. pp 171-93 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

Detailed autoradiographic studies on dogs showed plutonium-239 to be: a bone surface seeker; non-uniform on bone surfaces; buried by diffusely labeled post-injection bone; removed from bone by osteoclastic activity; concentrated in osteoclasts and macrophages; removed from bone surface by 6 months post-injection time; concentrated in macrophages with hemosiderin; and accumulated in macrophages of bone marrow at death. The accumulation of labeled macrophages is an indicator of altered kinetics of both macrophages and bone cells. Labeled macrophages were observed in 2.7, 0.9, 0.3, 0.09 and 0.05 μCi/kg, but not in 0.015 μCi ^{239}Pu/kg injected dogs. An improved method for studying the distribution of ^{239}Pu is described, in which fission fragment tracks and bone image in Lexan plastic films from bones containing ^{239}Pu were produced when irradiated by thermal neutrons (detailed neutron autoradiography). Preliminary results from counting fission tracks from samples of bones are discussed. (auth)

41296 DISTRIBUTION OF Pu AND Am: SUBCUTANEOUS ADMINISTRATION OF PuO$_2$ AND THE EFFECT OF CHELATION THERAPY. Johnson, Lamar J. (Los Alamos Scientific Lab., N. Mex.); Watters, Robert L.; Lebel, Jacques L.; Lagerquist, Clayton R.; Hammond, Stanley E. Contract No. AT(11-1)-119. pp 213-20 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

Translocation data obtained following subcutaneous implantation of PuO$_2$ in dogs, simulating Pu contaminated wounds, are presented. Tissue distribution of Pu and ^{241}Am, used as a tracer for Pu, with and without chelation therapy, are presented. Results observed include apparent tissue Pu and Am concentration equilibrium within the first two weeks after PuO$_2$ implants. Chelation therapy did not alter the Pu concentration in the tissues, but significantly reduced the average Am concentration in the skeleton and liver. The importance of rapid removal, where feasible, of imbedded Pu is reemphasized by these findings. The use of DTPA therapy for the oxide form of Pu in a contaminated wound appears to be of limited value. (auth)

41297 TRACHEOBRONCHIAL LYMPH NODE INVOLVEMENT FOLLOWING INHALATION OF ALPHA EMITTERS. Thomas, Robert G. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. pp 231-41 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

It is estimated that 50 years of chronic inhalation of a relatively insoluble material will result in a concentration in the tracheobronchial lymph nodes (TBLN) approximately 300 times greater than that in the pulmonary region of the respiratory tract. The maximum permissible lung burden (MPLB) of insoluble ^{239}Pu for occupational exposure based upon such an exposure schedule is 16 nCi. Using a 1000 gram lung, the corresponding concentration in TBLN at 50 years would be 4.8 nCi/gram. Spread homogeneously over the entire TBLN tissue, this would result in a dose rate of ~1.3 rads/day. By analyzing autoradiographs of TBLN following inhalation of ^{241}Am by beagle dogs, it was determined that only about 10 percent of a given lymph node was absorbing all of the released alpha particle energy, due to the short path length and residence in hot spots. Thus, the energy-absorbing fraction of the TBLN in an individual containing a MPLB of ^{239}Pu might receive 13 rads/day. Conversely, if the hot spot problem is ignored and the ^{239}Pu is assumed spread throughout all lymphoid tissue in the body, the dose rate may be reduced by a factor of 50 to 0.026 rads/day. This is still 6 times the recognized permissible occupational dose rate to soft tissues and could be interpreted to suggest a lowering of the MPLB to about 3 nCi. Due to the many uncertainties involved in such a decision at this time, such as the lack of information on the relative sensitivity of nodal tissue, it is recommended that current standards be maintained until more experimental data are available for evaluation. (auth)

41298 AGE-DEPENDENCE OF ^{239}Pu METABOLISM AND EFFECT IN THE RAT. Sikov, Melvin R.; Mahlum, D. Dennis (Battelle-Northwest, Richland, Wash.). pp 261-72 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

A number of studies were performed to evaluate the metabolism and effects of ^{239}Pu relative to animal age at time of administration. Included were experiments which have demonstrated differences in absorption and distribution following gavage at various ages. In other studies, the partition and microscopic deposition have been found to vary with the age at time of injection. The resulting effects are clearly influenced by metabolic differences as well as by the differences in age-related radiation sensitivity. In an analogous fashion, cross-placental transfer, distribution within the fetoplacental unit, and biological effect changed throughout gestation. These studies demonstrate that values obtained in the adult for calculation of permissible exposure limits to radionuclides may be inappropriate for immature individuals. (auth)

41299 CELLULAR DEPOSITION AND RETENTION OF ^{239}Pu IN RELATION TO THE INDUCTION OF NEOPLASMS. Taylor, David M. (Inst. of Cancer Research, Sutton, Eng.). pp 273-9 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

Greater understanding of the mechanisms by which ^{239}Pu, and other actinides, are transported round the body and deposited in cells and tissues is important in order to permit the extrapolation to man of toxicity data obtained in experimental animals. Studies of the subcellular distribution of ^{239}Pu in the liver, testes, and adrenals of rats have shown that lysosomes are major sites of ^{239}Pu localization. The possible significance of lysosomal association of ^{239}Pu is discussed in relation to tumor incidence in bone and soft tissues. The need for further comparative studies of the subcellular distribution of ^{239}Pu in human and animal cells is emphasized. (auth)

41300 DOSE MEASUREMENTS FROM SKELETAL PLUTONIUM COMPARED IN MAMMALIAN SPECIES. James, Anthony C.; Kember, Norman F. (Medical Research Council, Sutton, Eng.). pp 281-91 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

Measured concentrations of ^{239}Pu on endosteal bone surfaces are compared for a series of mammalian species. For 1 μCi/kg body weight injected, the surface concentration on lumbar trabeculae is 140 pCi/cm^2 in the rat, 227 pCi/cm^2 in the weanling rabbit, 258 pCi/cm^2 in the adult rabbit, and 444 pCi/cm^2 in the adult beagle. On the basis of a model whereby the bones are simply altered in scale from species to species, the concentration extrapolated to man would be approximately 800 pCi/cm^2. An empirical model giving a better fit to the observed concentrations in the smaller mammals gives an extrapolated value of approximately 700 pCi/cm^2. A higher concentration is predicted when measured values of the bone surface area : volume ratios are used to derive the surface concentration in man. Even if a reliable estimate of the bone surface concentrations for skeletally-deposited plutonium in man were available, leading to an accurate estimate of dose rate to osteogenic tissue, ignorance of the variation between species of the kinetics of normal and malignant cell populations would still give an uncertain estimate of risk. (auth)

41301 BONE SURFACES: WHAT ARE THEY? Vaughan, Janet (Churchill Hospital, Oxford). pp 323-32 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

Bone surfaces have a complex character. They consist of osteogenic cells lying on a mineral/matrix component which is made up of calcium apatite impregnating collagen fibres, and ground substance composed of carbohydrate protein complexes, lipids, and peptides. Plutonium deposited on bone surfaces is bound by osteogenic cells and their organelles, by specific bone glycoproteins, and possibly by collagen. The presence of plutonium within or on the sensitive osteogenic cells accounts for the great carcinogenicity of this radionuclide. In discussion of metal binding by bone in the future it is not sufficient to talk of bone surfaces. The constituent of the bone surface involved should be defined by experiment. (auth)

41302 RADIOELEMENT METABOLISM AND DECORPORATION AS INFLUENCED BY CHELATION AND MIXED LIGAND COMPLEXES: RAPID EXPERIMENTAL AND CALCULATIVE APPROACHES TO PREDICT IN VIVO BEHAVIOR. Schubert, Jack (Univ. of Pittsburg). pp 355-75 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

The role of mixed complexes of DTPA and EDTA in improved decorporation therapy is described. In particular, it is pointed out that generally two or more complexing or chelating agents will bind a metal ion more firmly than a single agent. The response of monomeric and polymeric ^{241}Am, and ^{239}Pu to chelating agents in decorporation therapy of mammals is shown to depend on the fact that the rate of depolymerization of the polymer by the chelating agent is much slower than the rate of formation of the chelate from the monomeric form. A simplified method for estimating the degree to which a chelating agent binds a radioelement in vivo is described. The method employs the so-called conditional or effective constant and side-reaction coefficients. It is also pointed out that the slope of the ascending and descending branches of the urinary or tissue excretion curves of a radioelement following chelation therapy can be utilized to determine the physicochemical state of radioelements deposited in the body (i.e., the degree to which the radioelement is in a monomeric or polymeric state). Such information can be useful for prognosis and for determining schedules of treatment. (TSS)

41303 TOXICITY OF ^{239}Pu RELATIVE TO ^{226}Ra IN MAN AND DOG. Lloyd, Elizabeth; Marshall, John H. (Argonne National Lab., Ill.). pp 377-83 of Radiobiology of Plutonium. /Stover, Betsy J. (ed.). Salt Lake City; J. W. Press (1972).

The relative toxicity of ^{239}Pu compared to ^{226}Ra in man cannot be regarded as being equal to that which has been found experimentally in dogs because of the different distribution patterns of the two isotopes and the very important differences in bone structures between man and dog. Some of the factors affecting the relative toxicities are: the surface/volume ratio of bone mineral in trabecular bone of the dog was found to be higher than the corresponding values in man by about a factor of two; the burial rate of surface deposits of ^{239}Pu in a 1.5 year-old dog is at least an order of magnitude greater than in an adult man. This burial rate in dogs appears to be critically dependent on age and decreases rapidly after the age of 1.5 years, the age at which most of the toxicity studies have been performed; the percentage of the marrow volume irradiated by alpha-emitting bone surface seekers is higher in the dog, about 25% compared with about 10% in man; the higher proportion of bone volume per unit volume of the vertebrae in the dog, about 35% as compared with 25% in man, may make the vertebrae in adult man more vulnerable to bone damage. All of these factors would lead one to expect differences in the hazards from ^{239}Pu and ^{226}Ra in man and dog. The first two factors would suggest that the relative toxicity of ^{239}Pu/^{226}Ra may be greater in man than in 1.5 year-old dog. (auth)

41304 DISCRIMINATION AGAINST TRITIUM BY FULLY DEUTERATED ALGAE. Crespi, H. L.; Stewart, M. L.; Kline, J. R.; Katz, J. J. (Argonne National Lab., Ill.). Health Phys.; 23: No. 1, 111-12(Jul 1972).

Since extensive growth of microorganisms takes place in heavy water it was considered of interest to ascertain whether deuterated organisms concentrate T. Autotrophic organisms grown in tritiated water discriminate against T, and it would be expected that discrimination against T in heavy water would occur, but to a lesser degree. Four species of algae grown autotrophically in heavy water were examined for their T content; experimental details are given and results tabulated. The green and blue-green algae consistently discriminated against T to the extent of 12 to 18%. The discrimination against T observed in algae grown in heavy water gives some assurance that autotrophic organisms growing in heavy water do not accumulate T. (UK)

41305 METABOLIC REACTION OF AN INHALED ACID ^{144}Ce–Cl$_3$ AEROSOL IN THE RAT AND THE INFLUENCE OF THE ALVEOLAR MACROPHAGES. Masse, R.; Skupinski, W.; Zagorcic, A.; Arnoux, B.; Lafuma, J. (CEA–EURATOM, Fontenay-aux-Roses, France). Strahlentherapie; 143: No. 2, 219-24(Feb 1972). (In German).

Cerium-144 of low pH, inhaled by the rat, was found to be present in different physicochemical forms in the lungs. The insoluble fraction fixed by alveolar macrophages is smaller than the fraction bound by the proteins of the lungs. The development of these fractions in the course of the month following the inhalation points to the significance of decreasing free activity in the tissue. A progressive contamination of the regenerated macrophages indicated a homogenous rather than a punctiform irradiation. (auth)

41306 UPTAKE OF ^{106}Ru BY EGGS AND FRY OF RAINBOW TROUT. Honda, Y.; Kimura, Y.; Tamura, Y.; Tanaka, C. (Kinki Univ., Higashiosaka, Japan). J. Radiat. Res.; 13: No. 2, 95-9(Jun 1972).

Experimental studies on the uptake and accumulation of ^{106}Ru by artificially fertilized eggs, advanced fry, and fingerlings of rainbow trout were conducted. The accumulation in the egg previously treated with drugs for control of bacterial growth on the egg was more rapid and higher than that in non-treated egg. The major part of ^{106}Ru in the egg was associated with the egg capsule on hatching. The accumulation in the fry increased with growth and transfer through the alimentary tract with the development of the digestive organs was observed. (auth)

41307 EFFECT OF DESFERRIOXAMINE ON THE ELIMINATION OF RADIOIRON. Saito, Hiroshi; Tamiya, Tadashi (Nagoya Univ., Japan). Radioisotopes (Tokyo); 21: No. 5, 293-7(May 1972). (In Japanese).

The effect of desferrioxamine (DFO), a specific iron chelating agent, on the elimination of ^{59}Fe from untreated, and iron overloaded mice was investigated. The amount of radioiron elimination was determined by whole-body counting for around two months. When DFO was injected before radioiron injection, the elimination of radioiron was marked, but it was less when DFO was administered after radioiron injection. The rate of elimination of radioiron was larger in the untreated mice than the iron overloaded, since the untreated mice took up larger amount of radioiron in the red cells than the iron overloaded, and intestinal bleeding was marked in the mice of both groups. On the other hand, the iron overloaded mice stored radioiron mostly in tissues and the effect of DFO, which removes iron from storage top soil, was not so marked, except the initial stage of the study, as compared to the loss due to intestinal bleeding. In addition to the above experiment, clinical procedures for the elimination of overdosed radioiron were introduced as follows; For ingested radioiron give 2 g of DFO orally or intramuscularly as soon as possible, and continue the dose for a week. Within one hour after the ingestion of radioiron, let vomit, rinse the stomach, and give laxatives. For injected radioiron, inject 2 g of DFO immediately and give the dose daily for a week. Deplete 400 ml of blood once a week, until the patient becomes iron deficient, then supply an equivalent amount of iron lost by blood depletion intravenously. If patient's hematopoiesis is damaged by radioiron, remove the radioiron incorporated red cells, and transfuse cold red cells. Administration of cold iron orally or intravenously after radioiron does not block the absorption of radioiron, nor flush out radioiron retained in the body. (auth)

41308 TOXICITY OF ^{137}CsCl IN THE BEAGLE: METABOLISM AND DOSIMETRY. Boecker, B. B. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. M.). Contract AT(29-2)-1013. Radiat. Res.; 50: No. 3, 556-73(Jun 1972).

Long-term biological effects of the chronic, relatively uniform whole-body radiation exposure from internally deposited ^{137}Cs are being studied in the beagle. This report summarizes metabolism and dosimetry data obtained during the first year after intravenous injection, the period during which most of the radiation insult was delivered. Sixty-six dogs were entered into the study, six with a mean initial ^{137}Cs body concentration of 3800 μCi/kg and five groups of 12 dogs each with 2800, 1900, 1400, 970, and 0 μCi/kg. Two-component exponential functions described the whole-body retention during the first 60 days while the dogs were housed in individual metabolism cages. Approximately 85% of the initial body burden was associated with the long-term retention component with a mean effective and biological half-life of 32 days. Retention changes seen after transferring the dogs to the combination indoor and outdoor kennel runs are described in relation to food consumption, exercise, age, temperature, and external contamination. These data were used to calculate cumulative absorbed whole-body beta and gamma doses for each dog. No dose-related effects were observed in whole-body retention or the calculated doses. When the cumulative total body doses were expressed as rads per initial mCi ^{137}Cs/kg body wt, the total dose to 180 days was 680, of which 50% was delivered in the first 30 days and 90% in the first 90 days. The normalized dose rate decreased from an initial mean value of 18.5 rads/day/initial mCi ^{137}Cs/kg body wt to 8.2 at 30 days and 0.2 at 180 days. Tissue distribution data obtained from 11 dogs that died 19 to 81 days after injection yielded similar concentration data for individual tissues as have been reported for experiments involving lower activity levels of ^{137}Cs. Calculated absorbed tissue doses based on these data were 0.6 to 1.5 times that calculated as an average whole-body dose. (auth)

Plants

41309 (COO–1156–54) RADIOECOLOGY OF SOME NATURAL ORGANISMS AND SYSTEMS IN COLORADO. Tenth Technical Progress Report, January 1, 1971–April 31, 1972. Whicker, F. Ward (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). 1 Apr 1972. Contract AT(11-1)-1156. 84p. Dep. NTIS.

Project activities and major findings are summarized for the calendar year 1971. Concerning the mule deer work, a three year study on the kinetics and distribution of strontium and calcium in captive deer is nearing completion, although some analytical work and interpretation and modeling remain as major activities in 1972. The goal of this study is a model of strontium-calcium accumulation in deer of various ages under specified circumstances of season, including modifications due to antler growth and lactation. Retention of intravenously administered ^{134}Cs by mule deer was investigated so that a two compartment model for cesium accumulation could be developed. Such a model will permit a calculation of forage intake by free-roaming deer using existing fallout ^{137}Cs data. Gastrointestinal retention of ingesta was investigated in captive deer using ^{51}Cr to provide additional data for models of radionuclide accumulation. As part of long-term studies on the persistence of fallout ^{137}Cs in mule deer, tissues from five animals collected in November–December, 1971 were assayed for ^{137}Cs and ^{131}I. Concerning the aquatic studies, the detailed investigation on the in situ kinetics of stable cesium in East Twin Lake was essentially completed. The results of the study are only briefly summarized in this report. A substantial effort was made during 1971 to examine levels of lead and mercury in trout from remote montane and alpine lakes and to investigate the importance of atmospheric fallout as a transport vector. Studies on the pika were concerned with effects of ^{60}Co gamma radiation on social interaction in the natural environment near the summit of Mount Evans. Results are discussed in relation to artificial stresses resulting from captivity and natural stresses such as predation. Placement of an 8,750 curie ^{137}Cs source in a native shortgrass plains plant community in 1969 afforded the opportunity to study radiation effects on the in situ ecosystem. The study was designed primarily to investigate the effects of chronic and seasonal semi-acute irradiation on vegetative structure. In addition to vegetation, arthropods, soil microorganisms and soil cores for chemical analysis have been sampled across the radiation gradient. Preliminary findings of these studies are presented in this report. Energy flow from the dominant grass of the shortgrass plains, Bouteloua gracilis, through arthropod consumers has been investigated by tagging the grass with ^{32}P and tracing its movement into primary and secondary consumers. Feeding rates of three common grasshopper species are being measured from data on accumulation and retention of ^{32}P from contaminated herbage. A status report on this investigation is given herein. (H.L.W.)

41310 ROLE OF ALGAE IN CYCLING OF RADIONUCLIDES. Zattera, A.; Bernhard, M. (CNEN–EURATOM, Fiascherino, Italy). Rev. Int. Oceanogr. Med.; 22: 1-24(1970). (RT/BIO(72)13).

The available data on uptake, loss, and stable content for elements which possess possible dangerous radioisotopes, are discussed. The factors influencing uptake and loss (e.g., physico-chemical states, stable concentration etc.) of ^{144}Ce, ^{45}Ca, ^{60}Co, ^{106}Ru, ^{89}Sr, ^{90}Sr, ^{65}Zn, and ^{95}Zr by algae are considered. The accumulation of trace metals by algae is proportional to their external concentrations. Uptake is related to physico-chemical forms of radionuclides. Concentration factors for the different elements vary from one time to sometimes more than a thousand times over their concentration in the environment. (auth)

41311 DETERMINATION OF URANIUM CONCENTRATIONS IN SEAWEEDS BY NUCLEAR TRACK DETECTORS. Su, Ching-shen (National Tsing Hua Univ., Hsinchu, Taiwan). Radiat. Eff.; 14: No. 1-2, 109-12(May 1972).

The uranium concentrations in some seaweeds were investigated by using nuclear track detectors to register the neutron induced fission tracks from the uranium in the samples. The laminaria and the porphyra tenera were chosen as samples for their uranium determinations. Chemical etched fission tracks on the mica and the Lexan polycarbonate detectors after approximately 2×10^{15} n/cm^2 integrated neutron flux irradiations were counted through an optical microscope at ×600 magnification. The average uranium concentrations in the laminaria and in the porphyra tenera were found to be 101.4 ppb and 164.4 ppb respectively. (auth)

41312 GAMMA SPECTROMETRY OF MARINE ORGANISMS FROM THE WEST COAST OF INDIA. Unni, C. K.; Viswanathan, R. (Bhabha Atomic Research Centre, Trombay, India). pp 533-9 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

Marine algae and invertebrates (clams and sponges) collected from the Bombay area of the west coast of India were analyzed for radioisotope content using γ spectrometry. Data are presented on the content of ^{137}Cs, ^{40}K, and ^{54}Mn in the organisms sampled. (C.H.)

41313 TRANSLOCATION OF ^{85}Sr, ^{137}Cs, AND ^{106}Ru IN CROP PLANTS. Handley, R.; Babcock, K. L. (Univ. of California, Berkeley). Radiat. Bot.; 12: No. 2, 113-19(May 1072).

The distribution of ^{85}Sr, ^{137}Cs, and ^{106}Ru between the root, the old growth and the new growth of bean, tomato, and corn was determined after incorporation of the isotopes into the plants via the roots. The results are compared with those obtained earlier in similar experiments using the xerophytic shrubs, Ceanothus and Adenostoma. As in the latter plants, almost all of the ^{106}Ru taken up by the crop plants was retained by the roots. Root retention of ^{85}Sr and ^{137}Cs was, however, much less in the crop plants. With respect to movement within the shoot (from old growth to new growth), ^{137}Cs was found in the crop plants as in the shrubs to be more mobile than ^{85}Sr. The difference in mobility was more pronounced in the crop plants. It is suggested that the relatively high mobility of foliarly applied ^{85}Sr found in the xerophytic shrubs may be related to their low transpiration rates. The low mobility of foliarly applied ^{137}Cs in these plants is ascribed to adsorption on or within the leaf cuticle. (auth) (UK)

New Tracer Techniques

Refer also to abstract 41121.

41314 (ACRH-37) SEMIANNUAL REPORT TO THE ATOMIC ENERGY COMMISSION. Gottschalk, Alexander; Doyle, Margot (eds.) (Argonne Cancer Research Hospital, Chicago, Ill.). Mar 1972. Contract AT(11-1)-69. 128p. Dep. NTIS.

Eleven papers published during the period covered by this report are included. An abstract of one of these papers appeared in NSA previously. A list of 22 additional publications by the staff during the period is included. (C.H.)

41315 (COO-119-244, pp 311-18) EFFECT OF CORTISOL ON INCORPORATION OF TRITIATED-TETRACYCLINE INTO BONE. Schafer, S. A.; Jee, W. S. S. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1971.

In Research in radiobiology.

Young-adult male mice were treated daily for eleven days with 25 micrograms cortisol per gram body weight. Three days before sacrifice, all mice were given a single injection of tritium-labeled tetracycline. Data indicate the following: (1) While control animals gained in total body weight throughout the experimental period, cortisol caused a rapid loss of weight, with a trend toward recovery after the first four days. The tritium-labeled tetracycline itself caused weight-loss in both groups of animals. (2) Blood radioactivity was the same in treated and control animals at 5 min after injection. The cortisol-treated animals showed less circulating tetracycline thereafter. (3) Bone weights at the time of sacrifice were less in cortisol-treated mice than in controls. (4) At sacrifice, total bone radioactivity was less in cortisol-treated mice than in controls. (5) Extraction of the tibiae with hydrochloric acid caused the release of the same percentage of tetracycline (diffuse component) in both groups. (auth)

41316 (COO-119-244, pp 319-31) DISTRIBUTION OF ^{3}H-TETRACYCLINE IN YOUNG-ADULT MOUSE BONE: A RAPID METHOD FOR THE QUANTITATION OF NEW BONE FORMATION. Schafer, S. A.; Higgenbottom, D.; Park, H. Z.; Jee, W. S. S. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1971.

In Research in radiobiology.

Three-month-old female mice were injected with 2 μCi of tritium-labeled tetracycline per gram body weight. Blood samples were taken by orbital sinus puncture at 0, 5 min, 1, 2, 3, 4, and 5 days. Bone samples were taken at 1, 3, and 5 days. The association of the tetracycline with the lipid and mineral phases of the bone was then investigated by sequential extraction with chloroform, chloroform/methanol, and chloroform/methanol/HCl. The data indicate the following: (1) The bone loses radioactivity as rapidly as the blood, with a biological half-life of 3.65 days. (2) Neither diffuse nor hot-spot tetracycline shows any correlation with the neutral lipid compartment of the bone. (3) The diffuse tetracycline comprises the majority of the compound deposited in bone, possibly amounting to 70%. This fact makes it meaningless to use total radioactive tetracycline measurements as an index of new bone formation, at least in short time periods up to five days after injection. Since the only relevant fraction is that bound in newly-mineralizing areas, so called hot-spots, the two components must be dissociated. (4) We would like to suggest that bone formation can be quantitated by measurements of tetracycline radioactivity remaining in bone after partial, controlled dissolution of the hydroxyapatite. Since the diffuse tetracycline is loosely associated with the bone, possibly by electrostatic bonds, there is a point during demineralization where the diffuse component is virtually eliminated leaving a preparation of hot-spot tetracycline. We therefore have a technique that replaces the time-consuming classical techniques now employed to study bone formation. (auth)

41317 (COO-1602-31) SIMPLE MICRORADIOMETRIC TECHNIQUE FOR THE RAPID MEASUREMENT OF MONOAMINE OXIDASE ACTIVITY IN RAT TESTICULAR MINCED AND TEASED-TUBULAR PREPARATIONS. Urry, Ronald L.; Jaussi, August W.; Ellis, LeGrande C. (Utah State Univ., Logan). [1971]. 21p. Dep. NTIS.

Two radiometric ways of measuring monoamine oxidase activity in testicular tissue preparations are described. Both methods measure the rate of conversion of 5-HT-^{14}C into 5-HIAA-^{14}C. The limitations and advantages of each method are discussed. (auth)

41318 (ORNL-tr-2604) RECENT TRENDS IN THE DEVELOPMENT OF RADIOACTIVE MEDICINALS. Ogawa, Hiroshi. Translated for Oak Ridge National Lab., Tenn., from Genshiryoku Kogyo; 17: No. 4, 13-17(1971). 9p. Dep. NTIS.

The production, availability, and use of radioactive pharmaceuticals in Japan are discussed. The 21 radioisotopes in most frequent use, for clinical studies both in vivo and in vitro, are listed. The availability of short-lived radioisotopes in Japan is discussed and the possible use of radioisotope generators such as the ^{99}Mo–^{99m}Tc and the ^{113}Sn–^{113m}In generators is suggested. The use of cyclotrons for research in Japan in the near future will no doubt make available such isotopes as ^{18}F, ^{67}Ga, and ^{111}In provided the cost factor is not prohibitive. The diagnostic use of the gaseous radioisotopes ^{85}Kr and ^{133}Xe is mentioned. Hopefully, the reactors of Japan will begin producing various radioisotopes whose import is presently impractical. (E.R.B.)

MATERIALS

Ceramics and Cermets

Refer also to abstracts 40734–40737, 40739, 40789, 41358, 41371, 41372, 42397, 42417, 42421, 42460, and 42477.

41319 (GEAP-10371) ZIRCALOY-CLAD UO_2 FUEL ROD EVALUATION PROGRAM. Final Report, November 1967–June 1971. Megerth, F. H.; Ruiz, C. P.; Wolff, U. E. (General Electric Co., San Jose, Calif. Nuclear Fuel Dept.). Jun 1971. Contract AT(04-3)-189. 230p. Dep. NTIS.

The Zircaloy-clad UO_2 pellet fuel rods in Assembly SA-1 received their initial irradiation in the VBWR, and were subsequently exposed in Dresden-1 to an estimated average burnup of 8.2×10^{20} fissions/cm^3 (29,800 MWd/tU). The peak and maximum rod-average burnups were 10.4×10^{20} fissions/cm^3 (37,900 MWd/tU) and 9.3×10^{20} fissions/cm^3 (33,900 MWd/tU), respectively. The total operating time in both reactors was 1827 days. Local peak powers of 14 kW/ft were attained by some rods early in operation. No full-wall cladding penetrations were detected. The average external corrosion weight gain shown by the fuel rod cladding at the end of operation was 480 mg/dm^2, and the maximum hydrogen content measured was 146 ppM. Burst samples exposed to about 7×10^{21} nvt > 1 MeV showed hoop stresses at rupture of 5100 kg/cm^2 at 343°C and 4400 kg/cm^2 at 454°C. Strains to fracture of 2 to 8 percent were obtained with no clear temperature dependence indicated. Maximum fission gas release was less than 1 percent. The irradiated UO_2 was examined by light and electron microscopy and by x-ray diffraction. Full cross-section and radially variant fuel samples were measured for burnup, uranium and plutonium isotopic composition, neptunium, americium, curium, and certain fission products. Relatively high levels of ^{232}U, ^{236}Pu, and ^{238}Pu were measured on some samples. (auth)

41320 (HEDL-TME-71-80) MICROSTRUCTURE CHARACTERISTICS OF PNL-1 AND 2 IRRADIATION TEST FUELS. Carlson, M. C. J. (Hanford Engineering Development Lab., Richland, Wash.). May 1971. Contract AT(45-1)-2170. 27p. Dep. NTIS.

Measurements providing quantitative porosity characterization, grain structure characterization and composition distribution evaluation for representative fuel batches used in EBR-II irradiation testing subassemblies PNL-1 and PNL-2 are described. Pore size-frequency distributions are shown for fuel batches MEE-9, MEE-12 and MEE-13 over the size range 0.2 to 128 microns. The results of submicron porosity evaluation from a cathodic vacuum etched MEE-9 sample indicate this technique is a promising approach to porosity observation and measurement to sizes as small as 300 Å. Pore size-frequency distribution and volume for pores over the size range 300 to 800 Å are shown for as-fabricated MEE-9 fuel. The relationship of porosity characteristics observed from the cathodic vacuum etched MEE-9 pellet surface to the characteristics observed from as-polished and acid etched surfaces is shown. Comparison of porosity evaluation by replica and direct surface observations in the scanning electron microscope shows no significant difference between the results from the two methods. The homogeneity Figure of Merit for PNL-1 and 2 fuel batch MEE-12 was calculated to be 0.999 as compared with 1.00 for a completely homogeneous material. Result of analysis showed inclusions containing stainless steel, aluminum, and tungsten. (auth)

41321 (HEDL-TME-72-53) SEL-810B COMPUTER DATA STORAGE AND RETRIEVAL SYSTEM. McClung, W. E. (Hanford Engineering Development Lab., Richland, Wash.). Apr 1972. Contract AT(45-1)-2170. 89p. Dep. NTIS.

A computerized data storage and retrieval system provides a method of keeping large amounts of information in a small space. Additionally, it affords the means of analyzing this stored data and drawing conclusions without the delay previously noted when it was necessary to first transcribe data and then make the analysis. The system in operation at HEDL provides an information library with respect to fuel pins being produced. The system may also be used to store and retrieve data of any nature. The program incorporates equations used in calculation of statistical data for every step of the production. The library pertains to all phases of production from the powder for pellets and rod stock for hardware, to the completed fuel pins and subassemblies. This system consists of three separate sections: the input and storage section, the recall portion, and the data system equations' subroutine. The program was set up in this manner to provide flexibility in its use and ease in making changes or additions when they are deemed necessary. (auth)

41322 (RDT-M-12-5-T(5-72)) THERMAL INSULATION, FLEXIBLE OR MOLDED, HIGH TEMPERATURE, LOW CONDUCTIVITY. (Division of Reactor Development and Technology (AEC), Washington, D. C.). May 1972. 6p. RSO.

A standard prescribing requirements for thermal insulation flexible or molded, high temperature, low conductivity, for nuclear and associated applications is presented. (J.R.D.)

41323 FORMATION OF URANIUM SESQUICARBIDE BY THE PARTIAL DECARBURIZATION OF URANIUM DICARBIDE USING MAGNESIUM OXIDE. Tagawa, Hiroaki (Japan Atomic Energy Research Inst., Tokai). Bull. Chem. Soc. Jap.; 45: No. 4, 1069-72(Apr 1972).

Formation of U_2C_3 by the reaction of UC_2 with MgO was studied by means of chemical and x-ray analyses at temperatures 1450 to 1700°C in vacuo. The reaction proceeds generating CO and Mg vapor and produces U_2C_3. The decarburization is represented by $2UC_2 + MgO \rightarrow U_2C_3 + CO + Mg$. UO_2 and UC were formed as the intermediate compounds. The amount of UO_2 was nearly equal to that formed by the reaction: $UC_2 + 4MgO = UO_2 + 2CO + 4Mg$. The lattice parameter of U_2C_3 was 8.0890 Å. The lattice parameters of UC_2 and UC varied with the reaction time. The main reaction sequence was suggested to be: $1/4UC_2 + MgO = 1/4UO_2 + 1/2CO + Mg$, $7/4UC_2 + 1/4UO_2 = U_2C_3 + 1/2CO$. The experimental results were in good agreement with those obtained by thermochemical calculation. (auth)

41324 BEHAVIOR OF DISCRETE PLUTONIUM-DIOXIDE PARTICLES IN MIXED-OXIDE FUEL DURING RAPID POWER TRANSIENTS. Freshley, M. D. (Battelle-Northwest Labs., Richland, Wash.); Aitken, E. A.; Wadekamper, D. C.; Johnson, R. L.; Lussie, W. G. Nucl. Technol.; 15: No. 4, 239-48(Aug 1972).

Transient tests were conducted on unirradiated oxide pellet-containing fuel pins at SPERT to investigate the possible effects of large single 550 μm diameter PuO_2 particles on transient behavior. Results show that the effect of the large PuO_2 particles was to reduce the cladding failure threshold energy from the range of 225 to 274 cal/gm of fuel to the range of 200 to 213 cal/gm of fuel. Clad perforation occurs by localized melting caused by the expulsion of PuO_2 particles through the cladding. The presence of single 550 μm diameter PuO_2 particles in mixed-oxide fuels does not appear to affect significantly the cladding failure threshold energy from that of mixed-oxide fuels with the normal PuO_2 particle size and distribution. Therefore, product specifications which limit the maximum PuO_2 particle size to 550 μm diameter in mixed-oxide fuels do not appear warranted from the standpoint of transient fuel performance considerations. (auth)

41325 SPUTTERED CADMIUM OXIDE AND INDIUM OXIDE/TIN OXIDE FILMS AS TRANSPARENT ELECTRODES TO CADMIUM SULFIDE. Mehta, R. R.; Vogel, S. F. (International Business Machines Corp., San Jose, Calif.). J. Electrochem. Soc.; 119: No. 6, 752-6(Jun 1972).

Thin films of cadmium oxide (CdO) and indium oxide–tin oxide ($In_2O_3-SnO_2$) were reactively sputtered from their respective metal or alloy targets CdO films combine sheet resistances of less than 100 ohms/square with optical transmission greater than 45% for wavelengths greater than 5000 Å, and make ohmic contacts with high-resistivity CdS films. Indium oxide–tin oxide films show optical transmission greater than 45% for wavelengths greater than 4000 Å and sheet resistances of 100 to 200 ohms/square. Indium oxide–tin oxide also makes useful contacts to CdS films, but reduces the resistivity of the CdS films. A band diagram is proposed which qualitatively explains the ohmic nature of the contacts between two wide bandgap materials. (auth)

41326 ACTIVATED SINTERING IN THORIA–YTTRIA SOLID ELECTROLYTES. Halbfinger, George Philip. New York; City Univ. of New York (1972). 212p. University Microfilms Order No. 72-13,465.

Thesis.

A method of production of thoria–yttria solid electrolyte material at about 1500°C, which is more than 500°C below the temperature normally needed, was studied and developed. The method is based on the activated sintering of the unalloyed powders using additions of 0.8 weight percent of either NiO or ZnO. A number of other oxides and halides were tested and found less efficacious. The sintering kinetics were studied by cathetometer measurements at temperature. An effort has been made to explore the mechanism of sintering principally by using existing theories of sintering rates and scanning electron microscopy. However, the standard theory is based on a model of one component, monosized spheres, whereas this investigation deals with thoria in plate form and with three components of different particle size. Consequently, the application of standard theory is qualitative at best. Analysis of the Kuczynski log-log and Johnson differential equation indicated that sintering occurs in three distinct regions: an initial very rapid shrinkage rate; a slower shrinkage region where volume diffusion is probably occurring; and a final slow densification region where inclusions probably slow down pore annihilation so that a temperature-dependent end point appears to be reached at short times. These regions resemble sintering in the presence of a liquid phase. A search for an eutectic in the system disclosed none below at least 1650°C whereas significant sintering occurred in the vicinity of 1300°C. Nor was evidence of a liquid found by scanning electron microscopy. Furthermore, the activation energy appeared to lie between 70 and 100 kcal/mole which is high for diffusion in a liquid phase. A number of solid state mechanisms are proposed as alternatives to the liquid phase theory. (Diss. Abstr. Int., B)

41327 DIRECT X-RAY STUDY IN A CONTROLLED ATMOSPHERE OF OXIDATION EQUILIBRIA OF URANIUM OXIDES AT 1150 AND 1200^{0}C. **Dode, Maurice; Touzelin, Bernard (Univ., Paris). Rev. Chim. Miner.; 9: No.1, 139-52(1972). (In French).**

Although the U–O equilibrium diagram indicates the complete disappearance of the U_4O_9 phase above 1125°C, x-ray diffraction techniques reveal reflections from this phase during the progressive oxidation of UO_2 at 1150°C; some transitory reflections from this phase still persist at 1200°C. The $UO_{2(2+x)}$ phase obtained has a very imperfect structure. The use of atmospheres having known oxygen potentials allow the oxidation pressure of these abnormal phases into U_3O_8 to be determined and the metastable nature of these states to be established. The observed phenomena appear to be related to the modification in the way the oxygen atoms are inserted in the UO_{2+x} lattice (as observed by Willis for compositions around $UO_{2.13}$). (France)

41328 SWELLING OF CYLINDRICAL DISPERSION TYPE FUEL ELEMENT IN NONUNIFORM TEMPERATURE AND NEUTRON FIELDS. **Likhachev, Yu. I. This paper was summarized in At. Energ. (USSR); 30: No. 1, 44-5(Jan 1971) as paper No. 454/5638. (In Russian).**

Axisymmetric swelling of a long cylindrical dispersion-type fuel cores in radially nonuniform temperature fields and neutron fields is discussed. It is suggested that the fuel consists of regularly spaced identical spherical cells in the form of hollow thick-walled spheres with spherical granules of fissionable materials inside. Swelling of individual cells S(r,t) is determined by the creep experienced by hollow spheres loaded by the increased internal pressure of gaseous fission and by the external pressure which is picked up by equal components of the spherical macroscopic stress tensor which originate during the interaction between volumes of the fuel element core swelling at different rates. The macroscopic stresses are determined by solving the problem of the creep experienced by a fuel core in the case of the bulk strain varying over the core cross section and increasing with time, and equal to the swelling S(r,t) of the spherical cells. (auth)

41329 KHIMICHESKAYA TEKHNOLOGIYA KERAMIKI I OGNEUPOROV. (Chemical Technology of Ceramics and Refractory Materials). **Budnikov, P. P.; Poluboyarinov, D. N. (eds.). Moscow; Izdatel'stvo Literatury po Stroitel'stvu (1972). 552p.**

Contemporary technology of refractory materials, structural ceramics, and special ceramics used in radiotechnology, high temperatures, and nuclear power is reviewed. Chemical properties, phase composition, and manufacturing data for a wide variety of such materials are given, such as the carbides, nitrides, and borides of Si, Ti, Zr, Ta, V, W, and Hf. Molding of articles from UO_2 and other U oxides, ThO_2, ZrO_2, BeO, and other metal oxides is discussed. Porcelains, semi-porcelains, faience, and their basic raw materials such as clay and kaolin, as well as production furnaces for firing such products are described. 68 references. (K.S.W.)

41330 HIGH-FLUENCE IRRADIATION-INDUCED DIMENSIONAL CHANGES OF CO-DEPOSITED CARBON–SILICON ALLOYS. **Kaae, J. L.; Stevens, D. W.; Bokros, J. C. (Gulf General Atomic Co., San Diego, Calif.). Carbon; 10: No. 3, 285-92(Jun 1972).**

The high-fluence radioinduced dimensional changes of co-deposited carbon–silicon alloys were investigated at several temperatures. The silicon, which was generally incorporated as silicon carbide, an irradiation-stable phase, led to reduced density and dimensional changes if sufficient silicon carbide was present. The density of the carbon phase tended to decrease with increasing silicon carbide content and was also an important variable. For silicon carbide fractions above about 0.3 and carbon densities below about 1.9 g/cm^3, the dimensional changes did not depend strongly on the irradiation temperature and were considerably smaller than those of unalloyed carbons. (auth)

41331 DESIGN AND APPLICATION OF BORON/ALUMINIUM TO FLIGHT STRUCTURES. **Forest, J. D. (General Dynamics Corp., San Diego, Calif.). Composites; 3: No. 1, 16-19(Jan-Feb 1972).**

Major advantages of composites in flight structures are high strength and stiffness coupled with low density, which can produce dramatic reductions in system weight and large increases in performance. Of the several types of advanced composites such as carbon fiber/epoxy, boron/epoxy, boron/aluminum, boron/aluminum possesses somewhat lower specific strength and stiffness. Other advantages include higher transverse and shear properties, higher buckling resistance, greater thermal stability, higher thermal and electrical conductivity, and more freedom in secondary fabrication and joining. The main drawback of boron/aluminum at present is its high cost, but there are indications that significant cost reductions will be possible in the near future. (auth)

41332 SIZE OF COHERENT DOMAINS IN THE BINDER METAL OF COBALT-BONDED TUNGSTEN CARBIDE. **Willbrand, J.; Wieland, U. (Krupp Forschungsinstitut, Essen). Int. J. Powder Met.; 8: No. 2, 89-93(Apr 1972).**

The binder phase was tested by x-rays and it was found that the size of equi-oriented regions may be about 100 microns or larger depending on the cooling conditions and the Co-content of the specimens. (auth)

41333 MICROHARDNESS OF VO_2 IN THE REGION OF THE PHASE TRANSITION. **Ablova, M. S.; Golubkov, A. V.; Zhuze, V. P.; Shelykh, A. I. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 12, 3137-8(Jun 1972).**

Translated from Fiz. Tverd. Tela; 13: No. 12, 3711-13(Dec 1971).

A study was made of the effects of the semiconductor–metal phase transition of a VO_2 single crystal on its microhardness. There is no sudden change in the microhardness at the phase transition, but its temperature dependence changes slope, indicating a decrease of the activation energy of dislocation movement in the metallic phase. Around the indentation on the surface, there is an orange (semiconductor) aureole in the blue (metallic) background. The effect of larger load on the aureole disappearance at high temperatures indicates a pressure coefficient of the transition temperature of ~8×10^{-4} °kbar, which is in fair agreement with the literature value of 6×10^{-5} °kbar. (D.L.C.)

41334 HIGH-TEMPERATURE THERMAL CONDUCTIVITY OF CERIUM DIOXIDE. **Chekhovskoi, V. Ya.; Stavrovskii, G. I.; Ivanov, A. B. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 6, 1090-3(Nov-Dec 1971).**

Translated from Teplofiz. Vys. Temp.; 9: No. 6, 1182-6(Nov-Dec 1971).

The thermal conductivity of cerium dioxide was measured in the temperature range 300 to 1200°C. The lattice and photon components of thermal conductivity were assessed. An empirical equation is proposed for calculating the thermal conductivity of cerium dioxide. The results are compared with published data. (auth)

41335 THERMAL CONDUCTIVITY OF VANADIUM OXIDE WITHIN THE RANGE OF HOMOGENEITY. **Aivazov, M. I.; Muranevich, A. Kh.; Domashnev, I. A.; Sarkisyan, A. G.; Gurov, S. V. High Temp. (USSR) (Engl. Transl.); 9: No. 6, 1086-9(Nov-Dec 1971).**

Translated from Teplofiz. Vys. Temp.; 9: No. 6, 1177-81(Nov-Dec 1971).

The thermal conductivity of vanadium oxide was studied between 100 and 1100°K within the range of homogeneity $VO_{0.79}$–$VO_{1.29}$. It was shown that at low temperatures heat transfer is mainly effected by phonons. For the composition $VO_{0.79}$ the electron part of the thermal conductivity was estimated in accordance with the Wiedemann–Franz law; this increases with temperature. An increase in oxygen content increased the degree of localization of the band electrons and reduced the total thermal conductivity. For a composition close to stoichiometric there was a sharp reduction in the phonon free path with temperature in the range 77 to 500°K. (auth)

41336 POSSIBILITIES FOR IMPROVING CREEP STRENGTH OF METALLIC MATERIALS. Bernhardt, Wolfgang (Bergakademie, Freiberg, Ger.). Neue Huette; 17: No. 2, 86-91 (Feb 1972). (In German).

Progress has been made in understanding basic creep phenomena and in developing materials with high-creep strength by metal hardening using foreign atoms and particles. Development of compound materials with fiber reinforcement leads to materials which may contain non-metallic components up to 80 vol.%. For the future, further progress in the development of materials with high-creep strength can be expected from a combination of hardening through mixed crystals and dispersion with fiber reinforcement. (tr-auth)

41337 RECENT WORKS AND TECHNICAL ASPECTS OF CARBIDE AND NITRIDE NUCLEAR FUELS FOR FAST BREEDER REACTOR. Sano, Tadao (Osaka Univ.); Imoto, Shosuke; Tanaka, Koji; Akimoto, Yumi; Kikuchi, Takeo. Nippon Genshiryoku Gakkaishi; 13: No. 11, 642-67(Nov 1971). (In Japanese).

Recent research and technical aspects of carbide and nitride nuclear fuels development for fast breeder reactors up to 1971 all over the world are summarized. It is pointed out that countries of the world continue or turn to concentrate on R & D of high efficiency carbide and nitride nuclear fuels and improved-type nuclear fuels for use in high-efficiency fast breeder reactors, which will replace the fast breeder reactors using oxide nuclear fuel appearing in early 1980's. The descriptions cover preparation and production of carbide, nitride and carbonitride, nuclear fuels, and fuels containing impurities; phase equilibrium and thermochemistry for the U–Pu–C–N–O system; physical and mechanical properties of these fuels; irradiation behavior, such as swelling, release of gaseous fission products, and structural change; compatibility between the fuels and cladding materials, including the compatibility between the carbide fuel bonded with sodium and stainless steel cladding, and the compatibility between the nitride, carbonitride and metal added carbide fuels, and the stainless steel cladding; nuclear fuel cycles for high-efficiency ceramic fuels; and present state of R & D in other countries. (Japan)

41338 IMPROVEMENTS IN AGGLOMERATING NUCLEAR FUEL PARTICLES. Horsley, Geoffrey Winton (to United Kingdom Atomic Energy Authority). British Patent 1,277,209. 7 Jun 1972. Filed 14 Oct 1968.

Reference is made to methods of fabricating porous fuel agglomerates the porosity of which allows cooling by passage of coolant through the pores. In the method described a fission product retaining coating is first applied to the particles, followed by a further coating of a silica-containing bonding agent in powder form. The mass of particles is then heated in an O_2-containing atmosphere to bond the particles at their points of contact, the heating being controlled so that a coherent layer of the bonding agent is formed on the particles. The fission product retaining coating may be multilayer, with an outermost layer of SiC. The bonding agent may comprise SiO_2/Al_2O_3 in eutectic proportions, or SiO_2/CaO, SiO_2/MgO, or SiO_2/TiO_2. The fission product retaining layer is bonded to adjacent particles by the bonding agent, with continuous pores extending through the agglomerate. Application to UO_2 particles is described. (UK)

41339 OXYGEN REDISTRIBUTION IN UO_{2+x}. Olander, D. R. (Univ. of California, Berkeley). J. Nucl. Mater.; 44: No. 1, 116-20(Jul 1972).

Rand and Markin have proposed a mechanism, which appears to be compatible with available measurements, for the redistribution of oxygen in oxide fuel bodies subject to a temperature gradient. Their model assumes that a constant ratio of CO_2/CO, in conjunction with the known temperature field, determines the local oxygen partial pressures by the equilibrium constant of the reaction $CO(g) + \frac{1}{2}O_2(g) = CO_2(g)$ according to: $K = (p_{CO_2}/p_{CO})/\sqrt{p_{O_2}}$. With T and p_{O_2} known functions of position, the variation of x in UO_{2+x} with position is determined by the thermochemistry of hyperstoichiometric uranium dioxide. The CO_2/CO ratio is adjusted until the average value of x is equal to the specified value. The validity of assuming a constant CO_2/CO ratio in this situation was studied. It has been suggested that a constant ratio is maintained by convection currents within the gas. However any circulatory processes which are vigorous enough to establish a constant CO_2/CO ratio would also tend to keep the oxygen partial pressure constant as well. It was found that the CO_2/CO ratio is not an appropriate parameter for analyzing oxygen redistribution in oxide fuels because it need not be constant across the fuel radius, as commonly assumed; and its value must be chosen by matching the average O/M. On the other hand, the total carbon pressure is a better parameter because for the rather reasonable assumption of equal gas phase diffusivities of CO and CO_2, p_c is independent of radial position; and it can be determined from the carbon impurity content of the as-fabricated fuel material. Although the model was illustrated for the specific case of hyperstoichiometric urania, the method may be applied to hypostoichiometric mixed oxide fuel if the appropriate thermochemical information is used. (R.C.K.)

41340 MODEL PROPOSED BY CORNELL AND TURNBULL FOR THE NUCLEATION AND EVOLUTION OF FISSION GAS BUBBLES IN URANIUM DIOXIDE. Monti, M. A. (Agip Nucleare SpA, Milan). J. Nucl. Mater.; 44: No. 1, 102-6(Jul 1972).

A mathematical treatment of the model proposed by Cornell and Turnbull, and extended by Speight, for the nucleation and evolution of fission gas bubbles in UO_2 is presented. (R.C.K.)

41341 VISCOSITY OF MOLTEN URANIUM DIOXIDE. Tsai, H. C.; Olander, D. R. (Univ. of California, Berkeley). J. Nucl. Mater.; 44: No. 1, 83-6(Jul 1972).

The viscosity of UO_2 is needed to analyze gross fuel movement in various potential accident situations in LMFBR. This transport property was measured from the melting point to 3000°C using an oscillating cup viscometer. The apparatus and method of data analysis have been described previously. A cylindrical crucible containing the sample is suspended in a vacuum furnace by a wire. The assembly is given an initial twist to displace it from the equilibrium position. The resulting motion is one of damped oscillation of a torsional pendulum. The period and decay constant of the oscillation are directly related to the liquid viscosity, which supplies the viscous drag that causes damping of the oscillation. Approximately 80 g of UO_2 was contained in a 0.31 cm wall thickness, 1.6 cm ID tungsten crucible bored from forged rod stock. The lid and support rod were electron-beam welded onto the crucible under vacuum. Prior to sealing, the UO_2 was baked in a hydrogen atmosphere at 1600°C for ten hours, which should produce stoichiometric material. The major modification of the technique was the method used to measure the parameters of the damped sinusoidal oscillation. A laser beam reflected from a polished surface on the oscillating crucible assembly periodically triggered a photocell in the vacuum tank. The output pulses from the photocell generated by passage of the reflected laser beam advanced the channel of a multichannel analyzer operating in the multiscaler mode. The entire system was operated in vacuum in order to prevent attack of the crucible and the furnace element by gaseous impurities, to eliminate any viscous drag on the oscillating system due to the surrounding gases and to reduce the heat loss by convection. (R.C.K.)

41342 THERMODYNAMIC STUDY OF A UC FUEL SIMULATING A BURNUP OF 100,000 MWd/t BY A VAPORIZATION METHOD. Lorenzelli, N.; Marcon, J.-P. (CEN, Fontenay-aux-Roses, France). J. Nucl. Mater.; 44: No. 1, 57-63(Jul 1972). (In French).

Using a vaporization method and also mass-spectrometric analysis, the chemical activities of the various constituents (carbon, uranium, and fission products) of a UC fuel designed to simulate a burnup of 100,000 MWd/t were determined. According to the C/U rate, we observed very substantial variations in the activities of carbon, uranium, and especially of the rare earth metals, which we related to the chemical state of each of these constituents in the fuel. Finally, we noted that the solution of fission products in UC did not detectably affect the thermodynamic stability of that phase. (auth)

41343 COEFFICIENT OF PARTITION OF URANIUM AND PLUTONIUM IN THE SYSTEM (UPu)C + $(UPu)_2C_3$. de Keroulas, F.; Calais, D.; Marcon, J.-P. (CEN, Fontenay-aux-Roses, France). J. Nucl. Mater.; 44: No. 1, 64-70(Jul 1972). (In French).

As part of a research program on mixed uranium-plutonium carbide, which is a possible fuel for fast reactors, we examined by microprobe analyzer the distribution of uranium and plutonium between the phases (U, Pu)C and $(U, Pu)_2C_3$. Two types of samples were available, with Pu/(U + Pu) ratios of 0.20 and 0.50. The proportion of $(U, Pu)_2C_3$ varied from 10 to 70%. Two equilibria temperatures, 1500°C and 1700°C, were used. Measurements of the distribution coefficients k_U = amount of uranium in (U, Pu)C/amount of uranium in $(U, Pu)_2C_3$, k_{Pu} = amount of plutonium in (U, Pu)C/amount of plutonium in $(U, Pu)_2C_3$ for each of the 14 samples led to values of the coefficients independent of temperature and proportions of the two phases. It is shown that with the help of two relationships—one defined by the proportion of phases (Z and (1 – z)) and by the total ratio $\Gamma = U/(U + Pu)$, $\Gamma = xZ + y\,(1 - z)$, where $x/y = k_U$ and $(1 - x)/(1 - y) = k_{Pu}$,—the other defined by the free energies ΔG of the two phases that $\Sigma\Delta G = [\Delta G(UC) = \Delta G(PuC)] - [\Delta G(UC_{1.5}) - \Delta G(PuC_{1.5})] = RT \log[(Y/1 - Y) \times (1 - x/x)]$ one can determine a priori values of x and y from a knowledge of Γ and z. By using the experimentally determined distribution coefficients and values of x and $y = {}_4(x)$ deduced from the second equation for arbitrary values of the various free energies, one can determine $\Sigma\Delta G$ experimentally. The result is consistent with our most recent measurement of ΔG for stoichiometric PuC. (auth)

41344 HIGH-TEMPERATURE DEFORMATION OF POLYCRYSTALLINE URANIUM CARBIDE. Routbort, J. L. (Argonne National Lab., Ill.). J. Nucl. Mater.; 44: No. 1, 24-30(Jul 1972).

The proportional limit, σ_p, of arc-cast hypostoichiometric (4.60 wt % C) and arc-cast hyperstoichiometric (5.00 wt % C) uranium carbide was measured in compression in the temperature ranges 700 to 1300°C and 1120 to 1600°C at a strain rate of $\sim 3 \times 10^{-5}$ sec^{-1}. The proportional limit is strongly dependent on composition, its magnitude for UC_{1+x} being much greater than for UC_{1-x}. Yielding in UC is thermally activated since the proportional limit depends exponentially on the inverse of the absolute temperature for both UC_{1-x} and UC_{1+x}, except in the case of UC_{1-x} at $T \leq 1130°C$, when free uranium melts and apparently facilitates grain-boundary separation. The apparent activation volume and sensitivity of the strain rate to stress were measured by performing stress-relaxation tests. The results suggest that there is a good correlation between the high initial yielding in UC_{1+x} compared to UC_{1-} and the magnitude of the internal stresses. (auth)

41345 INFLUENCE OF CERTAIN PREPARATION CONDITIONS ON THE ION-EXCHANGE PROPERTIES OF HYDRATED ZIRCONIUM OXIDE. .Chernykh, O. A.; Boichinova, E. S. (Leningrad Technological Inst.). J. Appl. Chem. USSR (Engl. Transl.); 44: No. 12, 2711-14(Dec 1971).

Translated from Zh. Prikl. Khim.; 44: No. 12, 2628-32(Dec 1971).

The sorption capacity of hydrated zirconium oxide depends on the conditions of its preparation, including the nature of the precipitant, the aging time of the primary gel, and the drying temperature. The capacity of one sample of zirconium dioxide for Cu(II), Co(II), and Ni(II) ions was determined under static conditions and was found to decrease with decrease of the crystallographic radii of the ions. Kinetic curves representing sorption of Cu(II), Co(II), and Ni(II) ions were recorded and it was found that equilibrium is virtually reached in 1 day with Co(II) and Ni(II) ions, and in 3 days with Co(II) ions. (auth)

41346 MECHANISM UNDERLYING RELEASE OF GASEOUS FISSION FRAGMENTS FROM CERAMIC NUCLEAR FUEL. Samsonov, B. V.; Frei, A. K. This paper was summarized in At. Energ. (USSR); 31: No. 2, 136(Aug 1971) as paper No. 514/5964. (In Russian).

Full copy of this paper is held by TIC.

The diffusion coefficient of gaseous fission fragments in ceramic nuclear fuel apparently declines when exposures as high as 10^{19} fission events per cm^3 occur. This decrease is manifested in a decline in the yield of gaseous fission fragments, and is accounted for by the appearance of vacancy pores in the intragrain crystalline structure during the irradiation process, with these pores then entrapping atoms of the fragments migrating within the grains. An analysis was made, on the basis of the experimental data, to determine the concentration and dimensions of those pores. Calculations show that there are always 3×10^{17} to 10^{19} free vacancy pores, 10 to 60 Å in diameter, per cm^3 in ceramic fuel (whatever the shape of the fuel), starting with doses $\sim 5 \times 10^{18}$ fissions per cm^3. The pores exhibit appreciable mobility and anneal out with an annealing constant $\sim 4 \times 10^{-6}$ sec^{-1}. A fraction (~5%) of the pores constantly trap fission fragments appearing during the fission process, and these become occupied pores, forming gas bubbles. The mobility of the gas bubbles is slower than the mobility of the free pores, so that the former disappear at a constant rate of $\sim 10^{-9}$ sec^{-1}. The mean migration life of atoms of gaseous fission fragments before they impinge upon free pores is 100 sec. The distance separating free pores is in the 50 to 500 Å range. Increased swelling, estimated to be 0.20% per each 10^{20} fission events per cm^3, is attributed to a buildup of these gas bubbles in the intragrain structure of the fuel. This occurs at temperatures to ~1500°C, and seems to continue as long as the crystalline structure is maintained. (auth)

41347 MICROSTRUCTURE OF BORON CARBIDE AFTER FAST NEUTRON IRRADIATION. Jostsons, A.; Dubose, C. K. H. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater.; 44: No. 1, 91-5(Jul 1972).

Boron carbide is used extensively as a neutron absorber in various types of nuclear reactors and currently is considered for use in the safety and shim rods of the Fast Test Reactor and eventually for fast breeder reactors. Unfortunately, little is known about the nature of radiation damage which may arise from displacement damage and from He and Li from the transmutation reaction $^{10}B(n, \alpha)^7Li$. Recently developed ion thinning techniques for preparation of transmission electron microscopy samples have enabled the direct observation of radioinduced defect structures in B_4C. The results of an electron microscope investigation of the nature of defects in boron carbide irradiated in a fast reactor are described. Specimens were prepared from pellets of Argonne National Laboratory "higher worth" control rod, capsule G, subassembly L-4008S, irradiated in Row 5 of the Experimental Breeder Reactor (EBR-II) at an estimated temperature of 500°C to a burnup of 1.7% of ^{10}B (5470 MWd). The microstructure of an as-irradiated pellet is characterized by a high density of black-spot defects except in denuded regions near grain boundaries. Twin boundaries, however, do not exhibit denuding of defects. The radiation damage structure resembles closely the defect clusters formed by the agglomeration of point defects created by displacements in neutron-irradiated metals at temperatures near 0.3 T_m which correspond to the present irradiation temperature of boron carbide whose melting point is about 2450°C. The results of the studies on irradiated as well as postirradiation annealed B_4C suggest strongly that the defect structure, for irradiation temperatures near 500°C, consists of small helium precipitates accompanied by strong lattice strain fields. (R.C.K.)

41348 ULTRASONIC COMMINUTION OF REFRACTORY COMPOUND POWDERS. Matsera, V. E.; Pugin, V. S.; Dobrovol'skii, A. G.; (and others) (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 12, 948-52(Dec 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 12, 11-16(Dec 1971).

It has been established that powders of refractory compounds can be comminuted by ultrasonic treatment. A study of the comminution kinetics of tungsten and refractory compound (TiC, ZrC, SiC, TiB_2, ZrB_2, and $MoSi_2$) powders demonstrated that the intensity of the process is a maximum during the first 2 to 5 min and subsequently diminishes, brittle materials being comminuted more effectively than ductile ones (for instance, tungsten). Particle size analysis indicated that a certain powder fraction is particularly susceptible to being comminuted. Hence, to increase the effectiveness of the process, it is best to employ fractions exhibiting the greatest propensity for comminution (for example, the <14 μ fraction in the work described above). During the ultrasonic comminution of both brittle and ductile materials, there was virtually no pickup of impurities (such as iron) from the bath vessel walls. This was of great importance in the milling of pure materials, where no contamination can be tolerated. (auth)

41349 INFLUENCE OF STOICHIOMETRY ON COMPRESSION CREEP OF URANIUM DIOXIDE SINGLE CRYSTALS. Seltzer, M. S.; Clauer, A. H.; Wilcox, B. A. (Battelle Memorial Inst., Columbus, Ohio). J. Nucl. Mater.; 44: No. 1, 43-56(Jul 1972).

Hyperstoichiometric uranium dioxide single crystal specimens have been creep tested in compression as a function of temperature, stress, and composition. The dependence of steady-state creep rates on stress and temperature varies with O/U ratio. At a stress of 10,000 psi, creep activation energies decrease from 135 kcal/mole to 57 kcal/mole as the O/U ratio increased from "stoichiometric" to 2.062. For O/U values above 2.001 creep rates can be fit by a power law stress dependence of the form $\dot{\epsilon} \propto \sigma^n$ where $n \approx 17$. At lower O/U levels n decreases to a value of 7. In the stoichiometry region of constant stress exponent, creep rates increase with the square of the oxygen excess ($\epsilon \propto x^2$) where x is given by UO_{2+x}. At high temperatures (above 1250°C) and low stress levels (whose values depend on stoichiometry) creep rates for UO_{2+x} single crystals have been found to vary linearly with stress. In this region creep rates are nearly independent of O/U ratio, and at a stress of 3,000 psi the activation energies for creep are approximately 130 kcal/mole for "stoichiometric" UO_2 and $UO_{2.01}$. (auth)

41350 KINETICS OF SURFACE SMOOTHING IN URANIUM MONOCARBIDE SINGLE CRYSTALS. Maiya, P. S.; Routbort, J. L. (Argonne National Lab., Ill.). J. Mater. Sci.; 7: No. 6, 609-14(Jun 1972).

The relaxation of sinusoidal profiles to flatness on the (110) surfaces of nearly stoichiometric uranium monocarbide single crystals was determined between 1800 and 2160°C in a helium atmosphere. From the wavelength dependence of the relaxation constants, it was established that the mass-transfer rate due to capillary forces is primarily controlled by volume diffusion in the lattice. The diffusion coefficient D_m associated with the relaxation process is given by the Arrhenius relation $D_m = D_0 \exp(-Q/RT)$, with $D_0 = (3.6 \pm 2.0) \times 10^{-3}$ cm^2/sec and the activation energy $Q = 72.2 \pm 2.9$ kcal/mole. These values are compared with the published tracer and mass-transfer diffusion data on uranium monocarbide. Faceting of profiles occurred after annealing in helium on the (100) and (111) surfaces indicating the presence of cusps in the surface-energy plot at these orientations. (auth)

41351 APPARATUS FOR VAPOR FREE MELTING OF URANIUM CARBIDE OR PLUTONIUM CARBIDE. Krauth, Axel; Teiwes, Hans-Juergen (to NUKEM-Nuklear-Chemie and -Metallurgie GmbH). . U. S. Patent 3,668,292. 6 Jun 1972. Filed 17 Jul 1970.

An apparatus is described for the vapor-free melting of fuel carbides consisting of uranium carbide, plutonium carbide or mixtures of these carbides. The apparatus comprises a cylindrical melting tube and two posts serving as electrodes which form a closed reaction space. At least one electrode is movable and the volume of the reaction space is changed during the melting process by readjustment of the upper post to the volume of the inserted material. (Official Gazette)

41352 CALCULATIONS CONCERNING THE CORROSION OF GRAPHITE FUEL ELEMENTS AND CORE COMPONENTS. Drescher, Hans-Paul (Kernforschungsanlage, Juelich, Ger.). pp 440-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The combined action of the diffusion of corrosive impurities in graphite, their reactions, and the overlap of these effects by the influence of temperature gradients—e.g., in a fuel element—are examined by means of a computer program. As a result, an evaluation of the risk of the graphite damage from corrosion not only at the surface but also some distance below the surface of graphite components is given. (INIS)

41353 PROCESS-CONTROL COMPUTER APPLICATION TO HIGHLY MECHANIZED FUEL ROD PRODUCTIONS. Gruenbecken, A. (Alpha-Chemie und -Metallurgie GmbH, Wolfgang, Ger.); Kurz, P.; Drosselmeyer, E.; Hagen, A. pp 518-20 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The reasons are given for the technical and economic necessity to combine an automatic data acquisition and processing computer directly with production. The technical possibilities are discussed. A description is given of a simulation procedure with regard to an optimization, with an IBM 360/65 being used for the model computing. (INIS)

41354 THERMAL CREEP OF PLUTONIUM-CONTAINING NUCLEAR FUEL OXIDES. Vollath, D. (Kernforschungszentrum, Karlsruhe, Ger.). pp 558-61 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Creep tests under pressure were carried out with samples of UO_2-PuO_2 mixed oxides in the temperature range between 1100 and 1700°C, with tensions between 50 and 500 kip/cm^2. The resulting activation energies and tension exponents are used in discussions of deformation mechanisms. (INIS)

41355 RADIAL DISTRIBUTION OF VOIDS IN THE IRRADIATED FUEL. Hoffmann, H.; Hellriegel, W.; Spieler, K. (Kernforschungszentrum, Karlsruhe, Ger.). pp 574-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A method is described for the determination of the radial distribution of cracks and voids in ceramic fuels. It is based on the evaluation of ceramographic polished sections which were prepared of cylindrical samples of irradiated fuel rods. (INIS)

41356 ADVANCES IN THE TECHNOLOGY OF NUCLEAR FUEL CARBIDES AND NITRIDES. Krauth, A.; Mueller, N. (Nuklear-Chemie und -Metallurgie GmbH, Wolfgang, Ger.). pp 578-81 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Reaction-sintering of carbide fuel pellets, or nitride fuel pellets, respectively, has proved to be a step in advancement of carbide and nitride fuel technology towards a decrease in fuel production costs. A mixture of sinterable uranium carbide powder, or uranium nitride powder is the basic material which is cold-molded and reaction-sintered either with plutonium oxide and carbon, or with a mixture of partly reacted plutonium oxide and carbon. The basic powder which represents about 80% of the total fuel material is produced by synthesis under vacuum at 1800 or 2000°C, and needs not be handled under plutonium conditions. (INIS)

41357 HIGH-TEMPERATURE EQUILIBRIA IN CERAMIC URANIUM, PLUTONIUM, AND THORIUM FUELS. Holleck, H.; Kleykamp, H.; Thuemmler, F. (Kernforschungszentrum, Karlsruhe, Ger.). pp 582-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Investigations of the equilibrium of multi-component systems (such as high-burnup oxide, carbide, and nitride fuels) yield important results with regard to the behavior of the fission products, the alteration of the fuel stoichiometry, and the separation of the constituents. These factors are the basis of evaluation of compatibility when considering the temperature gradients and concentration gradients of the constituents under irradiation. (INIS)

41358 FABRICATION, PROPERTIES, AND IRRADIATION BEHAVIOR OF SILICON CARBIDE (SiC) IN COATED FUEL PARTICLES. Gyarmati, E.; Nickel, H.; Balthesen, E. (Kernforschungsanlage, Juelich, Ger.). pp 642-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Silicon carbide interlayers seem to be particularly suited for use as diffusion barriers in pyrolytic carbon coated fuel particles for helium-cooled HTGRs, since they show a better retention ability towards Sr, Ba, and Ce and since they make for a lower heavy metal contamination than that which normally occurs on the outer PYC layers at temperatures exceeding 1700°C. The diffusion coefficients of the heavy metals as well as of the fission products, and thus the retention ability, are largely determined by the physical properties of the pyrolytically deposited SiC, and these in turn are dependent on the conditions governing the pyrolytic process. A study was conducted to define this interdependence, to improve the hitherto known methods of SiC characterization, and to test the behavior of the materials under operating conditions. An account of the SiC deposition process is given along with descriptions of the structure of the deposition, E module and tensile strength, and of a number of irradiation tests. (INIS)

41359 TECHNOLOGY OF ITR FUEL ELEMENTS. Gregorius, K. (Siemens AG, Erlangen, Ger.); Peehs, M.; Schoerner, H.; Holick, H.; Jester, A. pp 718-21 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The fabrication of thermionic fuel elements for the sodium-cooled, metal-hydride-moderated incore thermionic reactor is described. An account of appropriate materials for the various components is given. (INIS)

41360 NITRIDING OF Zr DIBORIDE. Cantarel, J. Y.; Montel, C. (Univ., Toulouse). Compt. Rend., Ser. C; 274: No. 2, 164-7(10 Jan 1972). (In French).

The reaction between Zr diboride and carefully dehydrated and deoxygenated nitrogen or ammonia at 1300°C leads to the production of Zr boronitrides having the ZrB_xN_{1-x} formula. The crystallographic parameters and chemical composition of these boronitrides were determined. The oxidation in air of these solids leads to different products depending upon whether the reactions are carried out at low temperature or at high temperature. The boronitrides are very resistant to acid attack. (France)

41361 URANIUM DIOXIDE-YTTRIUM OXIDE-ZIRCONIUM DIOXIDE MICROSPHERES. Fitch, F. T.; Smith, J. G. (to W. R. Grace and Co.). Canadian Patent 892,680. 8 Feb 1972.

Microspheres containing 30 to 55% uranium dioxide, 10 to 45% yttrium oxide, and 15 to 55% zirconium dioxide are produced by mixing an ammonia-releasing agent with a solution of the respective metal ions or an aquasol of the respective oxides to form a feed, introducing the feed into a dehydrating solvent, and recovering solid, partially dried microspheres. (auth) (Canada)

41362 GASEOUS PHASE CHEMICAL DEPOSITION OF Nb AND Ta BORIDES. Armas, Benigno; Trombe, Felix (CNRS, Montlouis, France). Compt. Rend., Ser. C; 274: No. 12, 1134-7 (20 Mar 1972). (In French).

Niobium and tantalum diborides were directly obtained in the solid state by the thermal decomposition between 1300 and 1600°C of $NbBr_5$ and $TaBr_5$, in the presence of BBr_3. The niobium boride was deposited on a Ta substrate and the tantalum boride was deposited on a Nb substrate. The effects of gas pressure on the deposition characteristics were considered. The borides were found to be compact, very hard (microhardness of 2600 kg/mm^2) and to adhere very well to their substrates when subjected to a gas pressure of 1.5×10^{-1} torr. Under a pressure of 2.5×10^{-2} torr, the adherence of the TaB_2 and NbB_2 deposits to their substrates was inferior and a crystalline orientation occurred. (France)

41363 ADSORPTION OF FLUORIDE ON THORIA AND ITS EFFECT ON HOT-PRESSED DENSITY. Stuart, W. I.; Whately, T. L.; Adams, R. B. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Aust. Ceram. Soc.; 8: No. 1, 6-9(May 1972).

Fluoride adsorbed on ThO_2 was studied using infrared spectrophotometry, thermogravimetric analysis (TGA) and differential thermal analysis (DTA). Fluoridated ThO_2 powders exhibit sharp exothermal DTA peaks. Peak temperatures lie within the temperature range 500 to 1000°C and are inversely proportional to the amount of fluoride adsorbed. The exothermal process can be attributed to low temperature microsintering accompanied by substantial loss of surface area and crystallite growth. Silicate adsorbed in the presence of fluoride partly inhibits microsintering. Adsorbed fluoride enhances the hot-pressed density of ThO_2 even at temperatures as low as 700°C. Adsorbed silicate partly inhibits the effect of fluoride on density. (auth)

41364 DETERMINATION OF ELEMENTS FOR MECHANICAL TWINNING OF RARE EARTH SESQUIOXIDES WITH MONOCLINIC STRUCTURE. Boulesteix, C. (CNRS, Orsay, France); Caro, P. E.; Loier, Ch.; Portier, R. Phys. Status Solidi (a); 11: No. 2, 771-82(16 Jun 1972). (In French).

Two different twinning processes have been previously observed in Ln_2O_3-B crystals. The indices of twinning are now determined. The two kinds of twins are reciprocal ones. The shear modulus increases from Pr_2O_3-B to Ho_2O_3-B. Twins are especially numerous in Sm_2O_3-B. (auth)

Metals and Alloys

Refer also to abstracts 40773 and 42477.

41365 (AECL-4159) MATERIALS RESEARCH IN ATOMIC ENERGY OF CANADA LIMITED. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Spring 1972. 19p. Dep. NTIS (U. S. Sales Only). AECL $0.50.

Brief reviews are presented of current research at Atomic Energy of Canada Ltd. on the following topics: vacancies in zirconium; correlation of alloy microstructures and properties; investigation of fluorine deposits on zirconium by proton activation; uranium carbide as a nuclear fuel; and pitting potentials. (Canada)

Corrosion and Erosion

41366 (HEDL-TME-71-99) FFTF SODIUM EROSION TESTS T-1-B AND T-1-D. Standley, F. R. (Hanford Engineering Development Lab., Richland, Wash.). Jun 1971. Contract AT(45-1)-2170. 126p. Dep. NTIS.

Results of sodium erosion tests T-1B and T-1D are presented. The tests were conducted to evaluate erosion effects of high velocity sodium through annuli with diametrical clearances ranging from 0.005 to 0.045 inch, and to measure seat leakage and evaluate erosion effects through two seat configurations, a cone-on-cone and a sphere-on-cone. The T-1B erosion test apparatus has five test modules including T-1-2, T-1-3, T-1-4, T-1-5, and T-1-6, with diametrical clearances of 0.005, 0.010, 0.010, 0.025, and 0.010 inch, respectively. All modules were fabricated from 304 SST; however, the T-1-4 module outer cylinder erosion surface was a split sleeve made from Stellite 6B and Inconel 718. The T-1-6 module was equipped with a conical plug and seat. This apparatus was operated approximately 3000 hours at 750°F in the Large Components Test Loop (LCTL) from October 1969 through February 1970. The T-1D erosion test apparatus fabricated from 304 SST has two test modules, T-1-7 and T-1-8, with diametrical clearances of 0.035 and 0.045 inch, respectively. T-1-7 was designed with a sphere-on-cone seat and T-1-8 had a cone-on-cone seat. Seat leakage was measured on both modules throughout the test; however, due to limited flow capacity of the test loop, T-1-7 was the only module to have high volumetric flow. This apparatus was operated for approximately 3800 hours at 750°F in the LCTL from June 1970 through December 18, 1970. (auth)

41367 EFFECT OF LANTHANUM AND YTTRIUM ON THE CORROSION RESISTANCE OF CHROMIUM IN NITRIC ACID. Tavadze, F. N.; Mikadze, O. I.; Rudoi, A. P.; Mandzhgaladze, S. N. (Inst. of Metallurgy, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 66: No. 3, 625-8(Jun 1972). (In Russian).

The effects of lanthanum and yttrium on the corrosion kinetics of chromium in nitric acid at room and boiling temperatures were investigated. (auth)

41368 PECULIARITIES OF CAVITATION DESTRUCTION OF REFRACTORY METALS AND ALLOYS. Bogachev, I. N.; Veksler, Yu. G.; Karasyuk, Yu. A. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Chern. Met.; No. 6, 111-16 (Jun 1971). (In Russian).

The special features of deformation and disintegration of refractory metals and their alloys were studied under conditions of cavitation-erosive action. (tr-auth)

41369 ACCELERATED OXIDATION OF ZIRCONIUM ALLOYS: SIGNIFICANCE OF SURFACE PREPARATION. Shirvington, P. J.; Bradhurst, D. H.; Heuer, P. M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Nucl. Mater.; 44: No. 1, 79-82(Jul 1972).

Recent experimental results indicate that the radiation enhanced oxidation of zirconium alloys observed in boiling water reactors might be explained solely in terms of high local concentrations of radiolytically-produced oxygen. These results showed that the out-of-reactor oxidation rates of some alloys, including Zircaloy-2, were sensitive to the oxygen overpressure (in the range 0.2 to 10 atm) contrary to a number of previous studies. While some of the differences were tentatively accounted for, some remained unexplained. Some additional results which help to reconcile the remaining differences between the results obtained and those previously reported are described. Detailed studies will shortly be submitted for publication. (auth)

41370 CORROSION INHIBITION. Pearl, Wesley L. (to General Electric Co.). U. S. Patent 3,663,725. 16 May 1972. Filed 23 Apr 1970.

A small proportion of oxygen and hydrogen, preferably about 100 to 300 parts per billion of oxygen and stoichiometric amount of hydrogen, is introduced into the boiler feedwater in an electrical power generating plant so as to decrease the corrosion rate of materials such as carbon steel in the feedwater heater chain. This technique is especially useful in water-cooled or moderated nuclear power plants since a suitable supply of oxygen and hydrogen are generated by radiolytic decomposition of water in the reactor core and because corrosion products in the water supply are especially harmful in such a plant. (Official Gazette)

41371 REACTIONS OF LIQUID SODIUM WITH TRANSITION-METAL OXIDES. PART IV. OXIDES OF IRON, COBALT, NICKEL, AND COPPER. Addison, C. C.; Barker, M. G.; Hooper, A. J. (Univ. of Nottingham, Eng.). J. Chem. Soc., Dalton Trans.; No. 10, 1017-19(1972).

The oxides of iron, cobalt, nickel, and copper are reduced by liquid sodium directly to the metal and sodium oxide. Only in the case of iron is a ternary oxide formed in the presence of an excess of liquid sodium. Solid-state reactions between sodium monoxide and the transition metals, carried out in vacuo, showed that reaction occurs at temperatures above 390° (Fe), 440° (Co), 480° (Ni), and 290° (Cu). (auth)

41372 REACTIONS OF LIQUID SODIUM WITH TRANSITION-METAL OXIDES. PART V. THE OXIDES Fe_3O_4, Co_3O_4, AND NiO; STOICHEIOMETRY AND REACTION RATES. Addison, C. C.; Pulham, R. J. (Univ. of Nottingham, Eng.). J. Chem. Soc., Dalton Trans.; No. 10, 1020-2(1972).

The stoicheiometry and rates of reaction of liquid sodium with the oxides Fe_3O_4, Co_3O_4, and NiO were studied by measuring the quantity of sodium consumed over a range of reaction times and temperatures. The nickel oxide reaction becomes rapid above 150°C and the sodium consumed corresponds precisely to complete reduction to nickel metal. Reaction of Fe_3O_4 is slow below

250°; reduction to metallic iron is only 80% complete at 250°C and this is attributed to ternary oxide formation. The oxide Co_3O_4 reacts rapidly below 120°C, and explosively above this temperature. Reduction to cobalt metal is about 90% complete at 120°C. (auth)

41373 METHODS AND REASONS FOR MEASURING THE CHLORIDE CONTENT IN LIQUID PENETRANT MATERIALS. Spanner, Jack C. (Westinghouse Hanford Co., Richland, Wash.). Mater. Eval.; 30: No. 6, 126-35(Jun 1972).

A program has been conducted to examine the potential for liquid penetrant materials to cause stress-corrosion cracking in Type 304 stainless steel and to develop chemical analysis techniques for reliably measuring the chloride content in commercial liquid penetrant materials. U-bend specimens of Type 304 stainless steel were coated with a variety of penetrant materials and exposed to a moist, 195°F atmosphere for about three months. The test specimens represented three different metallurgical conditions: solution-annealed, sensitized, and sensitized with a heavy grain etch to cause micro-crevices. Two of the 19 penetrant materials tested caused stress-corrosion cracking of the sensitized specimens. Two wet chemical techniques, which are adaptions of standard ASTM methods, have been found useful for measuring chloride impurities in the 10 to 1000 ppM range and above. One method is used only for hydrolyzable chlorides, and the other responds to organically bound chlorides as well. The results obtained are discussed along with a description of the testing and analysis procedures which were employed. (auth)

41374 COMPARISON OF THE BEHAVIOR OF INCOLOY 800, HASTELLOY X, AND INCONEL 625 FUEL CANS FOR STEAM-COOLED FUEL ELEMENTS. Francke, K. P.; Garzarolli, F.; Weidinger, H. G. (AEG-Kernenergieversuchsanlage, Grosswelzheim, Ger.). pp 444-6 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The precipitation behavior above 500°C and under neutron irradiation, the creep strength, tensile strength, and swelling behavior of these materials have been tested. As regards creep strength and ductility, Hastelloy X-280-cans show more stability under mechanical stresses caused by fuel, fission gas pressure, and cooling medium. Results of experiments in a hot-steam autoclave indicate complete corrosion resistance for Inconel 625 and Hastelloy X, and a slight sensitivity to intercrystalline corrosion for Incoloy 800. For all three materials strong effects of the chemical interactions can/fuel were observed only above an inner can temperature of 630°C, by which the maximum permissible can temperature for high burnup fuel elements seems to be reached. (INIS)

41375 STRENGTH, CORROSION, AND HYDROGEN EMBRITTLEMENT OF ZIRCALOY-2 ON BOILING WATER REACTOR CONDITIONS. Garzarolli, F.; Francke, K.-P.; Diez, W.; Fricke, W. (AEG-Telefunken, Grosswelzheim, Ger.). pp 547-50 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Investigations on Zircaloy-2 were carried out in order to obtain further optimization of the alloy in view of the fabrication of fuel element claddings. The corrosion behavior in boiling water reactors, the influence of the texture formation on the tangential breaking elongation after irradiation, and the local hydrogenation damages are examined. (INIS)

41376 METALLOGRAPHIC STUDY OF THE PRELIMINARY STAGES IN THE OXIDATION OF Hf. Pieraggi, Bernard; Dabosi, Francis (Ecole Nationale Superieure de Chimie, Toulouse). Compt. Rend. Ser., C; 274: No. 13, 1256-9(27 Mar 1972). (In French).

A metallographic study of the initial oxidation phase of Van Arkel Hf, in air or under reduced pressure, is presented. Thin plates of oxidized metal and Hf—O films were studied using transmission electron microscopy. The epitaxial properties of the oxide and metal, and the HfO_2 transformation characteristics are given. (France)

Preparation and Fabrication

Refer also to abstracts 40783, 41348, 41353, and 42459.

41377 (BARC-607) FURTHER STUDIES ON THE PILOT PLANT PRODUCTION OF REACTOR GRADE ZIRCONIUM SPONGE. Chintamani; Vijay, P. L.; Subramanyam, R. B.; Sundaram, C. V. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 19p. Dep. NTIS (U. S. Sales Only).

Results of further investigations are presented which were carried out on the production of nuclear-grade, ductile zirconium sponge, in 15 kilogram batches. In a specially designed stainless steel retort with arrangements for controlled 3-zone heating and continuous sensing of system pressure with an argon purge tube which could be operated either as a closed system under positive pressure or as a flow system under argon gas flow, the reduction of anhydrous zirconium tetrachloride both with magnesium alone and with magnesium and sodium was examined. The reduction product was subjected to a pyro-vacuum treatment to separate the by-product $MgCl_2$ and excess magnesium, and isolate pure zirconium sponge metal, which was crushed, graded and evaluated. Ductile zirconium sponge meeting nuclear-grade specifications was obtained both in straight magnesium and in bimetal reductions, with superior purity and better crushability in the latter case. The operations in particular established the suitability of the reduction retort design and the process conditions for larger scale operations. (auth)

41378 (CEA-R-4297) PREPARATION OF THIN URANIUM FILMS BY ELECTRODEPOSITION: APPLICATION TO THORIUM AND RADIUM. Soret, Christian; Tauveron, Nicole (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). May 1972. 52p. (In French). Dep. NTIS (U. S. Sales Only).

A method of preparing thin films of U by electrodeposition is described. The films are intended to facilitate α and γ measurements using the same substrate, and very high resolution α spectrometry. Comparative studies were made of the resolutions obtained in α spectrometry with different metallic supports. It is concluded that Pt is necessary for high performances. It is not possible to use Pt for simultaneous α counting and γ spectrometry of U isotopes, because exposure to radiations causes Pt to emit x rays, which are too energetic. In this case Mo is used. Substrates made of Mo are 35 times less expensive than those made of Pt. The results obtained are used to explain the theory of the electrodeposition of U, a subject which is not very extensively treated in the literature. The operating conditions defined for the electrodeposition of U were successfully applied to the case of Th. The electrodeposition principle for Ra has thus been generalized. Aqueous media were not satisfactory and nonaqueous media subjected to high voltages were used. (auth)

41379 (CONF-710342-4) FABRICATION DATA RELATIVE TO THE A 508, CLASS 2 FORGINGS FOR THE HSST INTERMEDIATE TEST VESSELS. Paper No. 4. Childress, C. E. (Oak Ridge National Lab., Tenn.). [nd]. 46p. Dep. NTIS.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

41380 (CONF-710342-17) AN ANALYTICAL BASIS FOR NOTCH SHARPENING BY FATIGUE. Paper No. 19. Merkle, J. G. (Oak Ridge National Lab., Tenn.). [1970]. 46p. Dep. NTIS.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

An important problem in the design of large fracture test specimens is the development of a practical and reliable method for sharpening the machined notches that are used to cause fracture. While gross load cycling does not appear to be a feasible method for notch sharpening by fatigue, for large specimens, local load cycling does appear to be a feasible method. Local compressive stresses, applied to the notch faces only, for example by hydraulic pressure, can produce the same crack tip stress intensity factor that would be produced by an overall tensile stress of the same magnitude. Calculations were made to estimate the number of load cycles required to initiate flaw growth by fatigue, at the base of a machined notch, and the number of load cycles required to grow the flaw a given distance by fatigue. Experimental data have been obtained, which tend to verify the analysis and to support the feasibility of notch sharpening by fatigue, using locally applied loads. (auth)

41381 (CONF-710342-18) TECHNIQUE FOR GENERATING SHARP CRACKS IN LOW-ALLOY HIGH-STRENGTH STEELS. Paper No. 20. Canonico, D. A.; Hudson, J. D. (Oak Ridge National Lab., Tenn.). [nd]. 3p. Dep. NTIS.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

A metallurgical method used to produce sharp cracks in ASTM A533B steel is described. Thicknesses from about ½ in. to 4 in. were successfully cracked. The thicker materials were more easily cracked because they provided a better heat sink and, consequently, the optimum microstructure and residual stress pattern. The cracks that were prepared were quite similar to those produced by the fatigue crack method. (P.C.H.)

41382 (CONF-710342-19) CRACK SHARPENING BY LOCAL FATIGUE. Paper No. 21. Derby, R. W.; Klindt, K. K.; Abbatiello, A. A.; Merkle, J. G. (Oak Ridge National Lab., Tenn.). [nd]. 10p. Dep. NTIS.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

A reliable and convenient method for sharpening flaws in large HSST specimens is described. Two different methods were used for monitoring crack growth; ultrasonics and correlation of the change in compliance of the specimen with crack growth. Both were successful. (P.C.H.)

41383 (DOCKET-701319-2) TEST AND RESEARCH REACTOR FUEL ELEMENT FABRICATION PLANT. Environmental Report, Supplemental Information. (U. S. Nuclear, Inc., Oak Ridge, Tenn.). Jun 1972. 14p. Dep. NTIS.

Additional information required in support of the environmental report on the construction and operation of a Test and Research Reactor Fuel Element Fabrication Plant near Oak Ridge, Tenn. is presented. Information is included on the geography, demography, meteorology, hydrology, and seismicity of the site area, the anticipated generation of all types of wastes, gaseous, liquid, solid, and thermal, a description of the ventilation and exhaust filtering systems at the facility, criticality safety data, and a list of all governmental approvals required with respect to air and water quality and the status of efforts to obtain these approvals. (L.C.L.)

41384 (RDT-C-7-6-T(4-72)) THERMOCOUPLE MATERIAL AND THERMOCOUPLE ASSEMBLY, CHROMEL-P Vs. ALUMEL, STAINLESS STEEL SHEATHED, MAGNESIUM OXIDE INSULATED. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Apr 1972. 21p. RSO.

A standard prescribing requirements for thermocouple material and thermocouple assembly Chromel-P vs Alumel, stainless steel sheathed, magnesium oxide insulated for nuclear and associated applications is presented. This standard supersedes RDTC 7-6T, dated July 1970. (J.R.D.)

41385 (RDT-M-4-3-T(6-72)) COBALT-CHROMIUM ALLOY STEEL CASTINGS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jun 1972. 11p. RSO.

A standard prescribing requirements for cobalt-chromium alloy steel castings for nuclear and associated applications is presented. This standard supersedes RDT M-4-3T dated July 1971. (J.R.D.)

41386 (RFP-1848) CASTING OF MULTIPLE ^{233}U METAL TARGET DISKS. Conner, William V.; Baaso, Donald L. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 17 May 1972. Contract AT(29-1)-1106. 5p. Dep. NTIS.

The preparation of four uranium-233 metal target disks is described. The disks were 1.5 inches in diameter with thicknesses of 0.050, 0.100, 0.200, and 0.640 inches. The disks were prepared using casting techniques. The three thinner disks were prepared simultaneously in a single casting. The variation in the thickness of each disk was within 3.5% of the average thickness of the disks. The conversion-to-metal of the U_3O_8 feed provided for the project is also described. (auth)

41387 (TID-25820) CHEMICAL VAPOR DEPOSITION AND CHARACTERIZATION OF TUNGSTEN-RHENIUM ALLOYS. Federer, J. I.; Schaffhauser, A. C. (Oak Ridge National Lab., Tenn.). [1971]. 11p. (CONF-720410-6). Dep. NTIS.

From third international conference on chemical vapor deposition; Salt Lake City, UT. (24 Apr 1972).

A method has been developed for depositing W-Re alloys in the form of 2-in.-wide by 16-in.-long sheet using hydrogen reduction of WF_6 and ReF_6. A minimum temperature of about 700°C and a maximum pressure of about 10 torr were found to be necessary for compositional uniformity. Deposits prepared with a $H_2/(WF_6 + ReF_6)$ ratio of about 3 had greater uniformity of thickness, smoother surface, and finer grain structure than deposits prepared with more hydrogen in the gas mixture. These deposition conditions minimized the nodular and porous microstructures previously obtained in sheet deposits on stationary substrates. Annealing studies showed that nominal 5% Re deposits have much greater grain stability than nominal 25% Re deposits. (auth)

41388 POSSIBILITY OF RHENIUM-TUNGSTEN ALLOY ELECTRODEPOSITION FROM MOLTEN ELECTROLYTES. Sominskaya, Z. M.; Nikitina, A. A.; Artamonova, E. K. Elektrokhimiya; 7: No. 9, 1250-5(Sep 1971). (In Russian).

The electrodeposition of rhenium with tungsten from various fused media was investigated. During the electrolysis of phosphate, borate, chloride, and chloride-fluoride electrolytes, with the introduction of oxygen-containing compounds of Re and W into the melt, a mechanical mixture of these metals separated out. Using equimolar mixtures of KCl, NaCl, and NaF, saturated with Re and W chlorides, alloys of these metals were deposited, which proved to be solid solutions of one of the metals in the other, or solid solutions containing a Re-W chemical compound. (tr-auth)

41389 WELDABILITY OF TANTALUM ALLOYS. Kammer, P. A.; Monroe, R. E.; Martin, D. C. (Battelle Memorial Inst., Columbus, Ohio). Weld. J. (N. Y.); 51: No. 6, 304s-20s(Jun 1972).

The factors which might affect the ductility of fusion welds in tantalum alloys include: interstitial impurities, welding parameters, alloy-elements, and weldment microstructure. The study of these factors showed that base metal alloy content and interstitial impurity content were most important. In general, machine fusion welds in simple, solid-solution strengthened tantalum alloys with a total alloy content (Hf, Mo, W, Re) greater than 13 atomic percent will have a room temperature minimum bend radius greater than 2t in the as-welded condition. The interstitial content of tantalum-alloy sheet should be less than 100 ppM by weight total of O_2, N_2, and H_2 with a carbon content of about 50 ppM or less if fusion welds are to be ductile at room temperature. The 2t bend transition temperature of fusion welds in Ta-5W-2.5Mo and Ta-10W-2.5Mo is <-320°F if the welds are stress relieved 1 h at 1500°F. This postweld stress-relief heat treatment will lower the 2t bend transition temperature of welds in Ta-10W-2.5Mo from >75°F to <-320°F. Tensile joint efficiencies from 86 percent at room temperature to 88 percent at 3500°F can be obtained with fusion welds in Ta-5W-2.5Mo and Ta-10W-2.5Mo, but the joint efficiencies of welds in Ta-17W are lower: 27 percent at 75°F and 68 percent at 3500°F. The application of an Sn-Al-Mo oxidation-resistant coating to fusion welds in Ta-5W-2.5Mo and Ta-10W-2.5Mo impaired the ductility of welds in both alloys. Elevated temperature exposures of 10h at 3000°F and 1 h at 3500°F in vacuum did not affect the ductility of base metal or welds. A more severe exposure of 10 h at 3500°F impaired the ductility of both base metal and welds in the Ta-10W-2.5Mo alloy. (auth)

41390 DIRECT REDUCTION AND NUCLEAR POWER. Antonioli, A. (Centro Sperimentale Metallurgico SpA, Rome). Met. Ital.; 63: No. 1, 12-22(Jan 1971). (In Italian).

A process is outlined in which sponge-iron is obtained by hydrogen reduction in fluidized beds at 20 atmospheres, and then melted in electric-arc furnace. At the present prices of energy sources an appreciable saving in energy expenses is reached in comparison with the conventional blast furnace-oxygen converter cycle. In order to allow the new process to profitably compete with the conventional steel-making also in mass-production, it must be further developed to ensure a safe operation of large facilities. This process is particularly adapted to use direct nuclear heat derived from a high-temperature gas reactor, placed within the heart of a steel work. By using in the electric-arc furnace the nuclear-generated power, the total energy expenses are particularly low, due to long-time running at full power and no energy transfer and transformation cost. In order to evaluate the production cost of raw steel it has been necessary to establish the installation outlay, after an accurate preliminary design of the non-conventional components, i.e., heat exchangers, steam-reforming reactor, and reduction fluidized beds. The detailed evaluation of raw steel production cost obtainable with the new process has shown possible a saving of over 3000 lire (5 dollars) per metric ton as compared with the conventional process. With due reservations on the accuracy of this figure, it is to be pointed out that the future trend of energy sources cost will possibly increase the saving. (auth)

41391 FRACTURE MECHANICS METHOD FOR EVALUATING WELDED JOINTS IN REACTOR PRESSURE VESSELS. Bartholome, Guenther. Schweissen Schneiden; 23: No. 11, 458-60(Nov 1971). (In German).

The use of the linear-elastic fracture mechanics approach in the study of weld cracks in pressure vessels is described briefly. Three factors must be known to determine the safety against fracture of components under stress conditions; these are the size of defects (length, depth, and geometry), the characteristic material values, and the stresses (internal pressure, residual stresses, and temperature). Difficulties experienced in practice are discussed and the use of this technique in the safety evaluation of reactor pressure vessels is outlined. A brittle fracture diagram for a pressure vessel is shown. (Metals Abstr.)

41392 BURNABLE POISON FOR NUCLEAR REACTOR. Yario, William R. (to Combustion Engineering, Inc.). U. S. Patent 3,663,218. 16 May 1972. Filed 12 Sep 1969.

An alloy is described for use as a burnable poison in nuclear reactors which consists of 0.5 to 14 wt % gadolinium and 0 to 4 wt % tin with the remainder being zirconium. (Official Gazette)

41393 METALLOGRAPHIC EXAMINATION OF URANIUM. Filho, Francisco Ambrozio; Gentile, Erberto Francisco. Metalurgia (Sao Paulo); 27: No. 163, 415-20(Jun 1971). (In Portuguese).

In developing techniques for quality control in the production of metallic U for use in fuel elements, three methods of preparing specimens of $\alpha-$U for metallographic study were tried. Of these, electrolytic polishing gave the best results for studying microtextures; manual and vibratory mechanical polishing provoked surface deformation of specimens, obscuring the microstructure and making it impossible to observe the shape and size of the grain. For examining inclusions, the mechanical methods were more successful. Uranium oxide and carbide inclusions were identified on the basis of their differing behavior under attack by a 50% HNO_3 solution. The level of inclusions in the metallic U product of reduction of UF by Mg was virtually the same regardless of whether the reduction vessel was lined with MgO or graphite. The refined U obtained by vacuum remelting of this product had fewer inclusions when remelting was done in a crucible of recrystallized alumina than when done in a graphite crucible. (Metals Abstr.)

41394 STUDY OF THE SINTERING OF MOLYBDENUM POWDER. Uskokovic, D.; Zivkovic, M.; Zivanovic, B.; Ristic, M. M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade. Univ. of Nis, Yugoslavia). High Temp. - High Pressure; 3: No. 4, 461-6(1971).

The kinetics and mechanism of sintering of disperse molybdenum powder under isothermal and non-isothermal conditions were studied. The results suggest that, to a certain degree, the diffusion-viscous flow mechanism can be regarded to be responsible for the mass transfer during the sintering of molybdenum powder. (auth)

41395 COLUMBIUM BASE ALLOY. McDonald, William K. (to Teledyne, Inc.). U. S. Patent 3,667,940. 6 Jun 1972. Filed 10 Apr 1969.

A niobium base alloy is described having high strength and oxidation-resistant properties particularly at elevated temperatures and also adequate low-temperature ductility. The alloy contains 20 to 33% hafnium, 11 to 20% tungsten and 0.5 to 2% zirconium, and may contain small amounts of one or more other elements including aluminum, iron, carbon and titanium to modify the properties of the alloy for various applications, and may also contain up to about 4% of tantalum without materially affecting the properties of the alloy except to increase its density. (Official Gazette)

41396 ELECTROSLAG WELDING OF LARGE CROSS SECTIONS IN REACTOR CONSTRUCTION. Theis, Erich (Rheinstahl Huettenwerke AG, Witten-Annen, Ger.). pp 407-10 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Welding procedures associated with wire electrodes, plate electrodes, self-melting electrode control, and welding material properties for in-situ welding are discussed. (INIS)

41397 PROBLEMS CONCERNING THE FABRICATION AND TESTING OF STRAIGHT-BEAD WELDED ZIRCALOY FUEL CLADS. Dressler, G.; Kleibeler, H.-J. (Metallgesellschaft AG, Frankfurt am Main. Vereinigte Deutsche Metallwerke AG, Duisburg, Ger.). pp 428-31 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Tests for fuel clad fabrication via profiling of Zircaloy sheet to split tubes, straight-bead welding, and after-treatment for homogenization of the properties transverse to the tube cross section are described. (INIS)

41398 USE OF A CO_2 LASER IN WELDING. Beche, M. (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). Soudage Tech. Connexes; 26: No. 1, 35-42(Jan 1972).

A description of the CSF $CO_2/N_2/H_2$ laser is given. Problems due to focusing difficulties and lack of power are discussed. An edge-to-edge weld was effected between 0.5mm thick stainless steel parts. Results obtained for stainless steel, Al, Cu, and certain light alloys (MgZn, ZrCu, and Zircaloy) are presented. The welding of thin (0.2, 0.3, 0.5mm) Inox cladding was effected. Investigations were also carried out in collaboration with the CERCA on the welding of plugs for EL4. Micrographic studies of the welds obtained are presented. (France)

Properties, Structure, and Phase Studies

Refer also to abstracts 40780, 40781, 40999, 42449, and 42454.

41399 (CONF-710342-1) FATIGUE CRACK GROWTH CHARACTERISTICS OF NUCLEAR PRESSURE VESSEL GRADE MATERIALS. Paper No. 1. Mager, T. R. (Westinghouse Electric Corp., Pittsburgh, Pa.). 17 Mar 1971. 10p. Dep. NTIS.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

The fatigue crack growth rate of pressure vessel grade materials is being studied in high temperature pressurized water. Initially, ultrasonic monitoring techniques were used to measure the crack growth in the 2T WOL specimens. However, utilization of ultrasonic monitoring techniques required fixing the test specimen to the test chamber head. It was concluded that because of the constrainment of the head, the stress intensity, K_{Ic}, at the crack tip was not well defined. As a result, the experiment was redesigned to utilize compliance calibration to experimentally measure rates of crack propagation. Twelve 2T WOL specimens fabricated from A533, Grade B, Class 1 base plate and weldment material were evaluated in PWR and BWR water environment. It was concluded that the water environment did not have an effect on the fatigue crack growth rate of the materials investigated. (auth)

41400 (CONF-710342-2) FATIGUE OF ASTM A-302 GRADE B STEEL IN HIGH TEMPERATURE SIMULATED NUCLEAR REACTOR ENVIRONMENT. Kondo, T.; Kikuyama, T.; Nakajima, H.; Shindo, M.; Nagasaki, R. (Japan Atomic Energy Research Inst., Tokai). 1970. 27p. Dep. NTIS (U. S. Sales Only).

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

The effect of high temperature aqueous environment on the rate of fatigue crack growth was studied. The apparatus consists of two electro-hydraulic fatigue machines combined with a water circulating system. The fatigue character of the material in water up to 270°C was compared with that in ambient air. The experimental parameters tested were: strain range, testing temperature, loading frequency, and content of oxygen dissolved in water. Measurements were made both on the number of cycles to fracture and the rate of crack growth under fixed longitudinal strain amplitudes. In the high temperature aqueous environment the fatigue life of the specimens with sharp double edge cracks was generally reduced relative to that in ambient air under most testing conditions employed. Such reduction was more pronounced as the cyclic loading frequency is lowered from 3 to 1 c/min, below which, however, the growth tended to pause frequently. Consequently the fatigue life was again prolonged in the lower frequency range in somewhat random fashion. The crack growth rate was increased with temperature up to around 180°C, but above this temperature the trend was sharply reversed. The crack growth rate was more steeply dependent on the strain range in water than in air, thus the environmental effect was more noticeable at higher strain or stress ranges. (auth)

41401 (CONF-710342-3) RELATIONSHIP BETWEEN MATERIAL FRACTURE TOUGHNESS USING FRACTURE MECHANICS AND TRANSITION TEMPERATURE TESTS. Paper No. 3. Sailors, R. H.; Corten, H. T. (Illinois Univ., Urbana). [nd]. 17p.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

Existing data were used to evaluate the relation between transition temperature-type data and fracture mechanics data for pressure vessel steels. In addition to empirical relations, the evaluation was based on known and generally accepted fracture mechanics fundamentals. It was concluded that existing data are insufficient to establish a relation between Charpy V notch data and the fracture mechanics toughness parameter, K_{Ic}, that allows an adequate quantitative evaluation of critical flaw size and structural integrity of nuclear pressure vessels based on C_v data. This is true for both upper shelf behavior and low and transition temperature behavior for unirradiated and irradiated materials. The most serious lack of data exists for unirradiated upper shelf behavior and for irradiated materials. As an interim measure, it is recommended that conservative methods of estimating K_{Ic} or K_{Id} (dynamic fracture toughness) be used. For the upper shelf behavior, the Rolfe–Novak relation is recommended. For low and transition temperature behavior, it is recommended that K_{Id} be measured for unirradiated material. For irradiated material, the curve for unirradiated material should be shifted along the temperature axis by an increment, ΔT, equal to the shift of the Charpy curve. (P.C.H.)

41402 (CONF-710342–5) HEAT TREATMENT STUDY FOR INTERMEDIATE TEST VESSELS. Paper No. 5. Berggren, R. G.; Stelzman, W. J. (Oak Ridge National Lab., Tenn.). [nd]. 8p. Dep. NTIS.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

Tensile and Charpy V-notch impact tests were made on a portion of a 26 in. ID (nominal) by $6\frac{5}{8}$ in. thick wall vessel shell identified as shell course No. 5. A part of the material was machined into tensile and Charpy blanks of axial orientation from the $\frac{1}{4}$ to $\frac{1}{2}$ thickness levels and retempered primarily in the temperature range of 1300 to 1345°F. Ductility properties indicated a small increase in elongation and a decrease in the reduction of area, especially for the axial oriented specimens, as the retemper temperature was increased. The Charpy-V impact results indicated curve shifts to higher temperatures indicating a loss of impact properties or toughness. However, retempering at 1340°F resulted in properties that still appeared acceptable for the intermediate test vessel studies. (P.C.H.)

41403 (CONF-710342–6) METALLURGICAL ASSESSMENT OF RETEMPER TEMPERATURE ON THE INTERMEDIATE VESSEL TEST COURSES. Paper No. 6. Canonico, D. A. (Oak Ridge National Lab., Tenn.). [nd]. 9p. Dep. NTIS.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

Studies were made to determine what reheat treatment methods could be applied that would provide the cylindrical body forgings with mechanical properties that fall within the design and test parameters guidelines. The results showed that retempering the ASTM A508 class 2 forgings at 1320 ± 25°F should provide a steel that is within the range of mechanical properties that have been set for the cylindrical shells that are to be used in the fabrication of the ITV (intermediate test vessel). It appeared that the carbon content of the forgings (about 0.27%) sets the minimum tensile values that are possible for this steel. The fastest cooling rate that is possible in these thick sections was rather slow and resulted in what, for these steels, can be compared to an austemper heat treatment. The slow rate permitted the carbides to agglomerate and, hence, tempering, in the classical sense, was not too effective. Retempering at a temper above the eutectoid resulted in the transformation of areas of the steel to austenite. Upon cooling, these areas retransformed. The cooling rate, however, which was in the range of 200°F/h, resulted in a microstructure not too different from that observed in the center of the thick plate. (P.C.H.)

41404 (CONF-710342–7) DYNAMIC FRACTURE TOUGHNESS PROPERTIES OF HEAVY SECTION A533 GRADE B CLASS 1 STEEL PLATE. Paper No. 8. Shabbits, W. O. (Westinghouse Electric Corp., Pittsburgh, Pa.). [nd]. 6p.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

Dynamic fracture toughness initiation properties and rate effect characteristics were studied for heavy-section A533 Grade B, Class 1 steel plate. The results indicated that the temperature dependence of dynamic toughness (K_{Id}) was similar to the static fracture toughness except that a shift or translation of approximately 60°F occurred at loading rates of K $10^4 \approx$ ksi $\sqrt{\text{inch}}$/sec. Results were also attained at various loading rates, and a composite graph of all the data tested at rates faster than static up to the millisecond range showed that the dynamic toughness (K_{Id}) appeared to decrease linearily with logrithmic increasing load rates. A major significance of these results were the high levels of toughness measured at 125°F. For either dynamic loading, or for a conservative estimate of static toughness properties at these temperatures, this data can be used to quantitatively determine the size flaws that would initiate unstable crack extension. (P.C.H.)

41405 (CONF-710342–8) STRAIN RATE AND CRACK ARREST STUDIES. Paper No. 9. Ripling, E. J.; Crosley, P. B. (Materials Research Lab., Inc., Glenwood, Ill.). [1970]. 15p.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

A review is presented on strain rate and crack arrest studies on compact tension specimens and contoured DCB specimens of pressure vessel steel. It was found that the data from these two types of tests yielded similar data. At low temperatures the arrest and dynamic toughnesses were also similar. An abrupt increase in both static and dynamic toughness at temperatures above 0°F, however, did not appear to occur for the arrest toughness values measured. (P.C.H.)

41406 (CONF-710342–9) EFFECTS OF CRACK SIZE ON THE GROSS STRAIN CRACK TOLERANCE OF A533-B STEEL. Paper No. 10. Randall, P. N. (TRW Systems, Redondo Beach, Calif.). [1971]. 38p.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

Gross strain crack tolerance is a measure of fracture toughness that is useful where yielding precedes fracture yet flaw size must be treated quantitatively. In these tests, rectangular bars containing surface fatigue cracks were pulled in tension at several temperatures. Strains were measured at the edges of the specimen on a gage length spanning the plane of the crack, and also in the gross section above and below the crack. Gross strain crack tolerance is the strain at maximum load on the gage length designated. It is a function of crack size, constraint and temperature, and perhaps other variables. In A533-B steel, the plots of all of the displacement measurements versus temperature showed a sharply defined transition temperature. Therefore, the effects of crack size are reported in terms of temperature at which strain in the net section reached 1.5 percent, or the temperature at which gross section yielding occurred. The two were essentially the same. Tests of three sizes of surface cracks in geometrically similar specimens have showed that increasing the crack size caused significantly higher temperatures to be required to reach the above criteria for gross strain crack tolerance. Application of these results to full-scale hardware required consideration of other variables, the foremost being strain gradients, which were common at the highly strained regions of heavy-walled vessels. Appended to the report are the results of exploratory tests of the effects of transverse and axial strain gradients and of their combined effects in a specimen containing a crack in the bottom of a notch. (auth)

41407 (CONF-710342–10) THREE-DIMENSIONAL ELASTIC-PLASTIC STRESS ANALYSIS FOR FRACTURE MECHANICS. Paper No. 11. Levy, N. J.; Marcal, P. V. (Brown Univ., Providence, R. I.). [1970]. 21p.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

Results obtained from the numerical solution for a semi-elliptic crack in a steel plate are summarized. The stress intensity factor along the minor axis of the crack was calculated and the significance of the moment induced by the uncracked region of the plate was assessed. In the plastic range, the magnitude of the triaxiality obtained at the crack tip along the minor axis was found to be $\frac{2}{3}$ of the value obtained in the plane strain. Also, a measure of the crack opening at the crack tip can be obtained from the value of the crack surface separation near the crack tip, as a function of load. It was found that this separation is proportional to the square of the imposed load. The feasibility of using the finite element method to extract useful and important information on the stress state near the tip of a semi-elliptic crack in a plate of a given configuration was demonstrated. (P.C.H.)

41408 (CONF-710342–11) EQUIVALENT ENERGY METHOD FOR CALCULATING ELASTIC-PLASTIC FRACTURE. Paper No. 12. Witt, F. J. (Oak Ridge National Lab., Tenn.). [1970]. 30p. Dep. NTIS.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

The equivalent energy method is set forth for relating flaw size, stress (i.e., maximum load to fracture), and temperature for frangible, transitional, and tough behavior of materials. The basic method depends on testing a flawed model of the structure of interest at the temperature of interest and knowing the volumetric energy ratio between model and prototype. The usefulness of the method depends substantially on the generalizations that can be made from volumetric energy ratio curves. Using the equivalent energy method as a means of comparing results from a number of fracture toughness investigations on ASTM A533, Grade B, Class 1 steel has led to the hypothesis that "the volumetric energy ratio for ASTM A533, Grade B, Class 1 steel is dependent primarily on thickness and temperature with little or no dependence on geometry or method of loading." A correlation of data from compact tension tests, dynamic tear tests, flawed tensile specimen tests, and gross strain tests partially substantiates this hypothesis. However, the correctness of the hypothesis and the applicability of the equivalent energy method must await evaluations from additional investigations. An elastic-plastic fracture mechanics procedure is set forth of which linear elastic fracture mechanics is a special case. Based on the above hypothesis, a new fracture toughness parameter, K_{Icd}, is introduced which is a property of the material in a particular thickness. K_{Icd} is easily obtained at any temperature. Examples of the application of this method to the A533 steel are presented. Current research will establish the feasibility and general applicability of the method. (auth)

41409 (CONF-710342-12) PROCEDURE FOR DETERMINING BOUNDING VALUES ON FRACTURE TOUGHNESS K_{Ic} AT ANY TEMPERATURE. Paper No. 13. Witt, F. J. (Oak Ridge National Lab., Tenn.). [1971]. 30p. Dep. NTIS.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

A method is proposed for determining upper and lower bounds on the fracture toughness of a material at any temperature of interest. Supporting technical arguments and examples are presented referenced to results obtained on the ASTM A 533, Grade B, Class 1 steel. The significance of the method to HSST irradiation investigations and to reactor surveillance programs is discussed. The results of research now in progress will assist in further evaluating the method. (P.C.H.)

41410 (CONF-710342-20) TESTING THE SIX-INCH-THICK FLAWED TENSILE SPECIMENS. Paper No. 22. Grigory, S. C. (Southwest Research Inst., San Antonio, Tex.). [nd]. 25p. Dep. NTIS.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

A 15 million pound tensile test facility was used to test a series of large tensile specimens for the Heavy Section Steel Technology (HSST) program. These specimens are A533 Grade B, Class 1, and are six inches thick, eighteen inches wide, four feet long, and contain flaws. The procedures used to create the flaws are discussed and pertinent data for ten tests at temperatures from 50 to 220°F and requiring loads up to 7.5 million pounds for failure are presented. Seven longitudinal specimens were tested at temperatures of 50, 75, 100 (three each), and 220°F (two each). Three transverse specimens have been tested at 100, 130, and 220°F. The mechanics of testing the large notched tensile specimens are also discussed briefly. (auth)

41411 (CONF-710342-21) ACOUSTIC EMISSION MONITORING OF THE 6-IN.-THICK FLAWED TENSILE SPECIMENS. Paper No. 23. Ying, S. P. (Southwest Research Inst., San Antonio, Tex.). [1971]. 20p.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

Acoustic emissions due to crack growth were monitored on four of the 6-in. flawed tensile specimens. Emissions in the 200-kHz range were monitored with an on-line data process system and recorded for permanent record on a wideband magnetic tape recorder. The experimental result of accumulative counts, N, fits the equation $N = AK^n$, where K is the stress intensity factor, and A and n are constants. Also, the number of counts and amplitude of each acoustic emission pulse are presented as a function of load. (auth)

41412 (CONF-710342-22) PREDICTION OF THE FRACTURE BEHAVIOR OF THE LARGE TENSILE TESTS USING THE EQUIVALENT ENERGY METHOD. Paper No. 24. Witt, F. J. (Oak Ridge National Lab., Tenn.). [1970]. 18p. Dep. NTIS.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

The equivalent energy method has been proposed as a procedure for relating flaw size, stress, and temperature for ASTM A 533, Grade B, Class 1 steel. The initial application of the method has been applied to the 6-in.-thick flawed tensile specimen behavior which is being investigated by Southwest Research Institute. Prior to each test a calculation of the fracture behavior of the specimen has been performed. The data from compact tension specimens have been used as a basis for prediction. Since results from 6-in.-thick compact tension specimens were available only up to 75°F, reasonable extrapolations were necessary to perform the analyses. The predicted results were compared with the experimental results. Considering the extrapolations necessary to make the predictions, it was found that the comparison generally supports the potential of the equivalent energy method for making quantitative fracture analyses. (auth)

41413 (CONF-710342-23) PRELIMINARY RESULTS OF STEEL MODEL TESTS. Paper No. 25. Derby, R. W. (Oak Ridge National Lab., Tenn.). [nd]. 11p. Dep. NTIS.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

The purposes and results of steel model tests on blocks cut out of HSST plate 01 are reported. The results showed that low-temperature creep was observed as low as 26°F. At room temperature the creep was observed with both dial and foil gages. Even for relatively small increments of pressure, as much as five minutes would often be required for the vessel to stop growing. This emphasizes the need for planning a loading rate. Backup methods are recommended when bonded strain gages are used to measure large strains at low temperatures. It was also found that the combination of flaw and low temperature does not greatly decrease the margin of safety. For an unflawed vessel the ratio of burst to code pressure was slightly better than four whereas for the flawed vessels it was, with one exception, slightly better than three. (P.C.H.)

41414 (CONF-710342-24) EFFECTS OF WARM OVERSTRESSING ON PRESSURE VESSEL STEEL PROPERTIES. Paper No. 29. Succop, L. N.; Pense, A. W.; Stout, R. D. (Lehigh Univ., Bethlehem, Pa.). [1969]. 23p.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

Studies were made on the effects of strain aging embrittlement arising from overstressing techniques on A533B and A516 grade 70 pressure vessel steels. Charpy impact tests and tension tests, in conjunction with fracture toughness tests, were performed to determine the relative degree of material damage caused by strain aging. Different levels of strain and different cycles of straining and aging were studied. Different aging temperatures were also studied, and a stress relief treatment was investigated. The results of the Charpy impact and tension test data indicated that strain aging embrittlement occurs in A516 grade 70 steel and A533B steel but is more severe for the A516 grade 70 than for the A533B. For both steels, repeated straining and aging treatments were noted to be more severe than single cycle strain age treatments. Different aging temperatures proved that 400°F had lesser effect on the A516 grade 70 steel than did 500 and 650°F. For the A533B steel aging at 400°F produced negligible response, while 500 and 650°F aging produced more embrittlement. The stress relief treatment for both steels improved the Charpy impact properties. The fracture toughness data for uniformly prestrained steels showed a moderate decreasing trend in K_{IC} for specimens that had been strained and aged. Specimens strained at a fatigue cracked notch were increased in toughness by the strain, but the benefits of this prestressing were degraded by subsequent aging treatments. High levels of notch strain produced K_{IC} values that were significantly higher than the base metal K_{IC} values. The K_{IC} values resulting from the high level notch strain followed by an aging treatment were decreased by the aging process. The K_{IC} values resulting from lower notch strain followed by an aging treatment were not above the level of the base metal and were, in some cases, below it. Finally, both uniform and notch prestrain studies indicated that stress relief treatments, following straining and/or straining and aging treatments, tended to decrease the K_{IC} for both steels rather than improve it. (auth)

41415 (CONF-710342-25) INDUSTRY COOPERATIVE PROGRAM ON MATERIALS PROPERTIES. Paper No. 30. Fogleman, E. L. (Lukens Steel Co., Coatesville, Pa. (USA)). [nd]. 16p.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

A cooperative testing program was established in 1966 to evaluate the mechanical properties of heavy-section steel plates, weldments, forgings, and castings used in the construction of nuclear reactor pressure vessels. The data from this testing procedure will be combined with that from the HSST and other studies to provide an understanding of the materials properties and processing variables requiring control to assure safety in the design and operation of nuclear pressure vessels. The results are given in 10 summary tables. (P.C.H.)

41416 (GKSS-71/E/19) CALCULATION OF THE DIFFUSION OF DISSOLVED HYDROGEN IN A ZIRCALOY-YTTRIUM COMBINATION AT SPATIALLY CONSTANT TEMPERATURE. Lahann, H. J.; Mertins, H. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). 1971. 37p. (In German). Dep. NTIS (U. S. Sales Only).

Isothermal diffusion was calculated for hydrogen dissolved in two metals that were joined by welding and that differed in their affinity for hydrogen. The mathematical solution was applied to the hydrogen uptake by yttrium in a Zircaloy–yttrium combination. The uptake was determined by the diffusion constant of hydrogen in the two materials, by Nernst's distribution coefficients, and by geometrical dimensions. A procedure for determining diffusion constants and distribution coefficients from experimental data is also reported. (tr-auth)

41417 (LBL-443) SPHEROIDIZATION OF THE GRAIN BOUNDARY PRECIPITATES IN Fe–Ta–Cr ALLOYS. Jin, Sungho (California Univ., Berkeley. Lawrence Berkeley Lab.). 17 Dec 1971. Contract W-7405-eng-48. 53p. Dep. NTIS.
Thesis.

The partly continuous grain boundary precipitates were fully spheroidized by cycling through the $\alpha-\gamma$ phase transformation. Both the ductility and strength were increased by the spheroidization treatment. The effect of chromium on the Fe–Ta binary system was found to enhance spheroidization as well as improve oxidation resistance. (auth)

41418 (ORNL-4757) CREEP-FATIGUE INTERACTION AND CUMULATIVE DAMAGE EVALUATIONS FOR TYPE 304 STAINLESS STEEL. HOLD-TIME FATIGUE TEST PROGRAM AND REVIEW OF MULTIAXIAL FATIGUE. Esztergar, E. P. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 126p. Dep. NTIS.

Components in steam generating service are subjected to long periods of steady operation interrupted by cyclic load and temperature variations. Cyclic strain has long been recognized as the source of fatigue damage, and design methods have been developed to prevent failure. The periods of steady operation received little attention in fatigue investigations, because at low temperatures fatigue damage was found to be independent of the time elapsed between cycles. At high temperatures, however, the conditions are reversed: during hold periods creep damage is accumulated and all time-dependent effects (relaxation, creep recovery, strain-rate sensitivity) become important in designing for cyclic operation. The influence of time-related effects on cyclic endurance is collectively called creep-fatigue interaction. The available data from time-controlled fatigue tests are assembled, and it is shown that hold-time data and continuous-cycle data can be presented in a form relating total time to failure and number of cycles to failure. The time-dependent effects are accurately described by equations of the general form, $t = k(n)^{-m}$, where t is total time, n denotes cycles to failure, and k and m are material constants. Assuming that the total damage is separated into cycle- and time-dependent fractions (n/n_f and t/t_r), the failure criterion can be expressed as $\alpha(n/n_f)^u + \beta(t/t_r)^v = 1$, where α, β, u, and v are interaction constants. The constants are evaluated for 304 stainless steel, based on the limited amount of available data. It is shown that the interaction is highly nonlinear and that the magnitude of interaction is dependent on the wave shape of the load cycle. Using these relationships as a guide, a recommended test program is assembled for generating data covering a wide range of hold time and strain ranges at temperatures of 900 to 1300°F. The test program is described in detail, and diagrams of the expected results are presented. (auth)

41419 (RFP-1831) EFFECTS OF ANNEALING ON THE MICROSTRUCTURE AND MECHANICAL PROPERTIES OF 0.100-INCH-THICK INGOT-SOURCE BERYLLIUM SHEET. Fergason, David L. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 26 May 1972. Contract AT(29-1)-1106. 31p. Dep. NTIS.

The effects of various annealing cycles on the microstructure and room temperature mechanical properties of a typical as-rolled, 0.100-inch-thick, ingot-source beryllium sheet were investigated. Microstructures from heat-treated material having various yield strengths were quantitatively analyzed. The data indicate that a direct correlation exists between the percent of the large, unrecrystallized grains in the characteristically duplexed microstructures and the 0.2% yield strength. It is suggested that the large grains have an orientation relationship to the plane of the sheet; this could explain their anisotropic deformation and recrystallization characteristics. (auth)

41420 METALLURGICAL STUDY OF HIGH STRESS ABRASION. Muscara, Joseph. Ann Arbor, Mich.; Univ. of Michigan (1971). 250p. University Microfilms Order No. 72-14,951.
Thesis.

Studies were made on high stress abrasion from the metallurgical point of view of relating structure to properties. A series of 27 Fe–C–Cr and Fe–C–Cr–Mo alloys with constant Cr : C ratios of 6.64 ranging from 1.40% C and 9.44% Cr to 5.07% C and 33.56% Cr with 0, 1.5, or 3 percent Mo in some of the hypoeutectic alloys were prepared. The alloys were designed to determine the effects of volume fraction, morphology, and composition of $(Cr, Fe)_7C_3$ carbides on high stress abrasion resistance. This was accomplished by increasing the Cr and C contents to vary the above carbide parameters while the matrix structure in all the alloys was austenitic and its properties were approximately constant. To study small changes in the carbide properties required a test which yields precise data and discriminates between materials. Since no such test was available, one was devised and evaluated. In the test developed, the specimen is abraded by sliding contact with bonded abrasives. To evaluate the abrasive wear response of the apparatus, six ferrous alloys were tested under varying abrasion conditions of abrasive type (alumina, silicon carbide, and garnet), load (3.5 to 29.2 pounds for a $^1/_4$-inch diameter pin), and abrasive particle size (80 to 200 microns). It was found that alumina is most suited for studies of ferrous alloys containing carbides of different microstructural properties. The abrasive test conditions of 15-pound loading for a $^1/_4$-inch diameter pin specimen on 80-micron particle size alumina abrasive yielded the most precise and reproducible data. Under these conditions the test discriminated between the alloys tested and rated them similarly to the ranking of the field tests in an ore grinding ball mill. The 95 percent confidence limits on the mean weight loss reported as a percentage of the mean ranged from ±0.353 percent to ±0.931 percent for the alloys tested. The Fe–C–Cr and Fe–C–Cr–Mo alloys were tested using the above abrasion parameters which simulate severe high stress abrasion. The high stress abrasion resistance of the hypoeutectic alloys did not increase with an increase in eutectic carbide volume fraction. A small decrease in abrasion resistance corresponding to one percent per ten percent increase in eutectic carbide volume was found. The different eutectic carbide morphologies had very little effect on high stress abrasion resistance. A two-fold increase in the carbide shape parameter (area/perimeter) improved the high stress abrasion resistance by approximately 5 percent. The abrasion resistance of the hypoeutectic alloys was increased by 2 percent per percent of Mo addition. The greatest effect in increasing high stress abrasion resistance was an increase in the primary carbide volume fraction of the hypereutectic alloys. The morphology of these massive primary carbides was considerably different from the eutectic carbide morphologies. The increase in primary carbide volume fraction increased the high stress abrasion resistance by one percent per percent primary carbide to an optimum at 20 volume percent. Based on the results of the present research, on scanning electron microscopy of the abraded surfaces and on results of field experience, a mechanism of high-stress abrasion for the alloys studied is proposed. (Diss. Abstr. Int., B)

41421 CALORIMETRIC INVESTIGATIONS OF LOW-MELTING ALLOY SYSTEMS. Singh, H. P. (Banaras Hindu Univ., India). Scr. Met.; 6: No. 6, 519-22(Jun 1972).

The construction and design of a liquid Wood's alloy solution calorimeter and a thermal analysis calorimeter, and their applications for the determination of the thermodynamic properties of the systems Pb-Bi, In-Bi, Hg-In, Hg-Cd, and of Wood's alloy are described. (auth)

41422 DIFFUSION OF SILVER IN CADMIUM. Jha, A. K.; Sinha, U. P.; Godkhindi, M. M.; Balasubramanian, V. (Indian Inst. of Tech., Bombay). Scr. Met.; 6: No. 6, 495-500(Jun 1972).

Results of experiments are presented on tracer measurement of Ag diffusion in polycrystalline Cd. The results show that activation energies of Ag diffusion in polycrystalline cadmium, in the higher temperature range, are lower than that expected for normal substitutional diffusion. It is noted that this does not by itself point to a mechanism other than normal vacancy diffusion. Investigations in the lower temperature range revealed a contribution of grain boundary diffusion. This would very likely affect the high-temperature data as well. The only confirmatory evidence would, therefore, come from more extensive single crystal data than are available. (auth)

41423 HYDROGEN IN TANTALUM QUENCHED TO LIQUID HELIUM TEMPERATURE. Hanada, R.; Suganuma, T.; Kimura, H. (Tohoku Univ., Sendai). Scr. Met.; 6: No. 6, 483-7(Jun 1972).

A technique of hydrogen quenching to determine very low concentrations of H in tantalum is described. The method involves very fast specimen quenching to minimize precipitation of hydrogen and correction of the precipitation process during quenching. (J.R.D.)

41424 COLD-WORKED Nb DAMPING MEASUREMENTS. Lupinc, V. (Laboratorio per la Tecnologia dei Materiali Metallici non Tradizionali, Milan). Scr. Met.; 6: No. 6, 459-63(Jun 1972).

Results of the measurements show that at the beginning of the Nb recovery Stage III, an irreversible pseudo-peak is generated by a temperature which induces damping due to dislocations or to interaction between dislocations and impurities; this damping disappears because of pinning by the oxygen, which at the same time, causes an increase of the vibration frequency. All these irreversible transformations are more pronounced the higher the initial cold-work rate. (auth)

41425 METHOD FOR CALCULATING TRACER DIFFUSION COEFFICIENTS FROM THE ACTIVITIES MEASURED THROUGH SERIALLY-SECTIONED SURFACES. Kinloch, D. R.; Hobbins, R. R. Jr.; Birchenall, C. E. (Univ. of Delaware, Newark). Scr. Met.; 6: No. 6, 431-6(Jun 1972).

A method for calculating diffusion coefficients of solutes at low concentrations in solids as measured by radioactive tracer diffusivities determined from sectioning data on specimens is described. No approximation is required in the analytical calculation. (J.R.D.)

41426 DIFFUSION IN THE SYSTEM Pd–V INVESTIGATED BY MEANS OF AN ELECTRON MICROPROBE. Lamparter, Peter; Krabichler, Traudl; Steeb, Siegfried (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Naturforsch.; 27b: No. 6, 960-5(Jun 1972). (In German).

Diffusion processes were investigated by means of quantitative electron-probe-microanalysis at 600 to 1300°C. The composition of the diffusion zone corresponds quite well with the phase diagram. The following phases were observed: Pd-solid solubility, Pd_3V, Pd_2V, and V-solid solubility. Below 900°C the growth of the diffusion zone is retarded; above 900°C the layer grows according to $d = k \cdot \sqrt{t}$. For all phases observed, according to Matano's method the coefficients of the interdiffusion were determined. The temperature dependency of these coefficients as well as that of the k-values follows an Arrhenius law. Thus the activation energies of the layer growth and of the interdiffusion were obtained. The determination of the intrinsic diffusion coefficients by the observation of the Kirkendall-effect is discussed. (auth)

41427 UNIT FOR DETERMINING THE INTEGRAL NORMAL RADIATING POWER IN THE TEMPERATURE RANGE 600 TO 1500°K. Petrov, V. A.; Radzyukevich, T. E. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 6, 1153-8(Nov-Dec 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 6, 1253-9(Nov-Dec 1971).

A unit is described for determining the integral normal radiating power of solid substances in the temperature range 600 to 1500°K, using a semiconducting bolometer as a radiation receiver. Experimental data on the radiating power of molybdenum are given. (auth)

41428 EFFECT OF PRESSURE ON THE ELASTIC PROPERTIES OF INDIUM. Voronov, F. F.; Goncharova, V. A. (Inst. of High-Pressure Physics, Podolsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 12, 3146-7(Jun 1972).

Translated from Fiz. Tverd. Tela; 13: No. 12, 3719-20(Dec 1971).

The elastic properties of polycrystalline indium were studied by an impulse ultrasonic method up to 20-kbar. The propagation rates of both longitudinal and transverse waves were determined. The density, elastic moduli, Debye temperature, and their pressure derivatives were calculated for 293°K. The Young's modulus E and the volume elasticity K_S and K_T are nonlinear with pressure, while the shear modulus G increases linearly with pressure, and the Poisson's ratio σ decreases slightly. On specimens cut from coarse-grained ingots, there was a reproducibility problem. (D.L.C.)

41429 ELECTRICAL RESISTIVITY OF LIQUID BINARY ALLOYS. II. Cd–In SYSTEM. Bernabai, U.; Gauzzi, F. (Univ., Rome). Met. Ital.; 63: No. 1, 9-11(Jan 1971). (In Italian).

The electrical resistivity of 19 Cd–In liquid alloys was measured in the temperature range between $t_L + 5°C$ and $t_L + 60°C$ (t_L = liquidus temperature). The resistivity increases with the temperature. The thermal coefficient as function of alloy composition is maximum at the eutectic composition and decreases as In concentration increases from 50 at to 60 at %. This thermal coefficient behavior is related with the presence of clusters in liquid phase. Pure liquid Cd and In resistivity values have also been re-determined. (auth)

41430 LIQUID METAL TRANSPORT PROPERTIES. Pasternak, Alan D. (Univ. of California, Livermore). Phys. Chem. Liquids; 3: No. 1, 41-53(Jan 1972).

Viscosity and self-diffusivity data for ten liquid metals are correlated by use of the theory of corresponding states and the reducing factors defined by Helfand and Rice. The transport data are used to determine relative values of the pair-potential energy parameters, which are found to have a linear relationship with melting point. By using density data, it is possible to construct reduced correlations for diffusivity and viscosity as functions of reduced temperature without explicitly choosing distance parameters. (auth)

41431 STUDY OF VARIOUS PHASES OF THE RECRYSTALLIZATION OF REFINED URANIUM AFTER COLD WORKING AT AMBIENT TEMPERATURE. Ferran, G. (CEN de Saclay, Gif-sur-Yvette, France); Cizeron, G.; Lacombe, P. J. Nucl. Mater.; 44: No. 1, 1-23(Jul 1972). (In French).

Uranium, twice vacuum-melted by electron bombardment to purify it to a level of <200 ppM of impurities, was cold-rolled to 30 to 40% reduction, annealed at 340°C and finally cold-rolled by 90%. The process of transition from the worked to the recrystallized state was followed by measuring resistivity during isothermal or isochronal anneals, by hardness measurements, and by x-ray diffraction to seek textural changes. These various techniques led to the conclusion that uranium strongly deformed at 20°C first undergoes a recovery process. Subsequent recrystallization proceeds in two stages: formation of grains of uniform size ($\sim 1\ \mu m$) with large mutual misorientations followed by growth of the larger grains in the manner of secondary recrystallization. The main change of texture away from the rolling texture occurs during the second state of recrystallization; this textural change is determined by selective growth of certain grains. (auth)

41432 ANISOTROPY OF SECONDARY IN-REACTOR CREEP OF ZIRCONIUM ALLOYS RELATED TO TEXTURE. Holicky, M. J.; Schroeder, J. (Univ. of Waterloo, Ont.). J. Nucl. Mater.; 44: No. 1, 31-42(Jul 1972).

In this work it is shown that recent results obtained at Atomic Energy of Canada Limited (AECL) from in-reactor creep tests on cold-worked zirconium–2.5 wt % niobium pressure tubes, substantiate the bounds proposed previously for principal coefficients of anisotropy of the zirconium alloy continuum by considering texture. An attempt was made to calculate these coefficients directly using pole figures acquired for two pressure tubes from AECL. The results appear to substantiate that secondary, in-reactor creep of cold-worked zirconium alloys is texture-dependent, for stresses larger than 15,000 psi. (auth)

41433 SIMPLE METHOD FOR DETERMINING THE POLE FIGURE OF ZIRCONIUM ALLOY TUBING. Kelly, P. M.; Watson, K. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Nucl. Mater.; 44: No. 1, 71-8(Jul 1972).

A simple inclined section method for determining the pole figure of heavily drawn zirconium alloy tubing from a single texture run on a composite specimen consisting of up to 24 tube sections is described. The technique can be used for other materials and results in considerable savings in time and effort. The problem of obtaining reliable random intensity levels for a composite specimen is overcome by integrating the total diffracted intensity during the texture run. This data can be used to calculate a random intensity level for the particular specimen and set of experimental conditions used in the texture run. The integrated intensity values can also be used to calculate both the orientation parameter and the fraction of prism planes oriented for slip. The calculation is simple and gives relatively accurate results. (auth)

41434 GRAIN-BOUNDARY PENETRATION OF AUSTENITIC STAINLESS STEEL BY CESIUM OXIDE. Maiya, P. S.; Busch, D. E. (Argonne National Lab., Ill.). J. Nucl. Mater.; 44: No. 1, 96-8(Jul 1972).

The problem of chemical interactions between fission products (such as cesium, molybdenum, tellurium, and iodine) and austenitic stainless steel in the presence of oxygen is important to the development of the Liquid Metal Fast Breeder Reactor (LMFBR). The results of out-of-reactor studies of the penetration of Type 304 stainless steel by Cs–O solutions and cesium oxide, which are some of the fission-product species, are discussed. It was found that grain-boundary penetration of stainless steel by liquid cesium containing low levels of oxygen does not occur, but extensive intergranular penetration does occur when stainless steel is exposed to either oxygen-saturated cesium or cesium oxide. The study also established that isothermal penetration of stainless steel by cesium oxide follows a linear rate law. (auth)

41435 CHROMIUM DIFFUSION IN α-ZIRCONIUM. Tendler, R. (Comision Nacional de Energia Atomica, Buenos Aires); Varotto, C. F. J. Nucl. Mater.; 44: No. 1, 99-101(Jul 1972).

Experimental results of studies of bulk diffusion of ^{51}Cr in α-zirconium are reported. The diffusion experiments were carried out on two batches of zirconium polycrystals of 99.5 and 99.999% purity. The grain sizes ranged from 0.20 to 2 mm diameter. The diffusion samples were wafers 8 to 12 mm in diameter and 5 mm thick. A thin layer of ^{51}Cr was deposited on one face of each wafer by an electrolytic technique. The deposit thickness ranged from 100 to 500 Å, and with activities of 10^4 to 10^5 cpm. The samples were lapped with a lapping machine designed for that purpose, which assured the parallellism of the faces to within 1 μm. NaI(Tl) crystals were used as radiation detectors. The penetration profiles were in accordance with the thin layer solution of the diffusion equation in a semi-infinite cylinder. Both counts of the activities of the removal layers and counts of the residual activity were used for the profile determination, with good agreement. Two typical penetration profiles are shown. Except for a very short anomalous zone of about 10 to 20 μm from the surface of the samples, good straight lines were obtained on the semi-logarithmic plot. An Arrhenius plot of the diffusion coefficient D_{Cr} of ^{51}Cr in α-zirconium for the temperature range studied is presented. No significant differences were found for different degrees of purity or grain size of the samples. (R.C.K.)

41436 TRANSPORT OF ^{60}Co IN FLOWING, NONISOTHERMAL SODIUM. Roy, P.; Dutina, D.; Armijo, S. (General Electric Co., Sunnyvale, Calif.). J. Nucl. Mater.; 44: No. 1, 107-12 (Jul 1972).

Studies were made to estimate the magnitude of radioactive materials transport in large sodium systems. The objectives of the studies were to measure corrosion and deposition rates of cobalt-60 in flowing sodium systems; obtain an activity balance between corrosion and deposition of cobalt-60; and to establish the sensitivity and feasibility of studying mass transport of radioisotopes with doped, non-irradiated specimens in order to avoid severe contamination of the test loop and facilitate on-line counting. Radioactive samples were prepared that consisted of Type 316 stainless steel rings electroplated with cobalt-60 (on the outer surface only) and heat-treated in vacuum at 1000°C for 3 hr. The diffusion cycle was determined from a solution of Fick's Second Law for diffusion into a semi-infinite solid from a nonreplenished source of negligible thickness. Values of the diffusion coefficient of cobalt in stainless steels were not available; consequently, diffusion coefficients for nickel in stainless steel were used. The penetration profile for cobalt-60 into the samples (calculated on the basis of $D_{Co} = D_{Ni}$) is given. It was found that doping with small quantities of radioactive corrosion products (e.g., cobalt-60) by diffusion yields ideal specimens for studying transport of radioactive corrosion products in flowing sodium systems; use of this type of specimen considerably reduces interference from background radiation during on-line counting and minimizes safety problems associated with specimens irradiated in the reactor; on-line counting methods are capable of resolving activity changes in the order of 10 μCi in low-activity test loops; by using specimens with low total activity but high surface activity, a 94% activity balance between corrosion and deposition of cobalt-60 was obtained in this test; and that 70% of cobalt-60 released from the source remains in the hot leg isothermal section. (R.C.K.)

41437 ARC-CAST MOLYBDENUM-BASE TZM ALLOY: PROPERTIES AND APPLICATIONS. Briggs, Janet Z.; Barr, R. Q. (Climax Molybdenum Co., New York). High Temp. - High Pressures; 3: No. 4, 363-409(1971).

During the some 12 years that vacuum-melted TZM has been commercial, considerable information has been developed on its properties. Basically, its physical properties, corrosion resistance and oxidation resistance are similar to those of unalloyed molybdenum. TZM's advantages over unalloyed molybdenum are its higher recrystallization temperature, which permits retention of work hardening to higher temperatures, and its superior toughness. A major advance over the past 12 years has been improvements in processing and fabricating. It is now feasible to make almost any type of part from TZM, often with conventional equipment, although special care and sometimes preheating are required. TZM was originally developed for the aerospace field in applications where high hot strength was thought to be necessary. More recently, however, its interesting combination of properties, particularly high thermal conductivity, high stiffness, low thermal expansion, high hot hardness, and excellent resistance to many molten metals, has led to a much broader field of use, including die-casting dies and cores, hot-working dies, mandrels, heating elements and boats. The future looks bright for TZM as more design engineers become acquainted with its properties and realize that its performance far outweighs its cost in many applications. (auth)

41438 GRAIN-SIZE DEPENDENCE OF SNOEK PEAKS IN NIOBIUM. Ahmad, M. S.; Szkopiak, Z. C. (Univ. of Surrey, Guilford, Eng.). J. Mater. Sci.; 7: No. 6, 701-7(Jun 1971).

The effect of grain size on the oxygen and nitrogen Snoek peaks in niobium was studied. It was observed that the conversion factor K given by $C = K\delta_{max}$, where C is the concentration of oxygen or nitrogen and δ_{max} the height of the corresponding Snoek peak, is concentration independent up to about 0.06 and 0.04 wt% oxygen and nitrogen respectively. The variation of K with grain size (d) obeys the relationship $K = K_0 + k_k d^{-1/2}$, where K_0 represents the value of K for an "aggregate of crystals without boundaries" and k_K the grain size dependence of K. (auth)

41439 DEFORMATION TEXTURES OF b.c.c. METALS (TUNGSTEN). Rieck, G. D. (Univ. of Tech., Eindhoven, Netherlands). High Temp. - High Pressures; 3: No. 4, 419-24 (1971).

The available experimental information on the details of the texture resulting from swaging and drawing of bcc metals (tungsten) is discussed. A consistent picture of the drawing texture of polycrystalline tungsten seems to be now available and it may serve as a basis for future models of the deformation mechanism. (auth)

41440 PRECIPITATION BEHAVIOR AND TENSILE PROPERTIES OF X8CrNiMoVNb 1613 (4988), INCOLOY 800, AND INCONEL 718 AFTER COMPATIBILITY ANNEALING WITH UC AT TEMPERATURES BETWEEN 600 AND 800°C. Stumpf, W. E.; Goetzmann, O. (Kernforschungszentrum, Karlsruhe, Ger.). pp 416-19 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Horizontal tensile test specimens in contact with UC-powder have been annealed at 600, 700, and 800°C for up to 1100 h. The changes in tensile strength and breaking elongation following this treatment were studied. The precipitation behavior at the reaction interface of the canning material has been observed by electron microscopy. (INIS)

41441 NON-DESTRUCTIVE METHOD TO DETERMINE LOW HYDROGEN CONCENTRATIONS IN METALS, APPLIED TO THE DIFFUSION OF HYDROGEN IN ZIRCALOY-YTTRIUM COMBINATIONS. Frisius, F.; Hackbarth, H.; Wille, P. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). pp 432-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Equipment has been designed and constructed at the reactor station Geesthacht for the determination of the hydrogen concentration in metals with the aid of neutron scattering. The first application of the method—the study of hydrogen diffusion in a sample of yttrium and Zircaloy plates welded together—is described. The method is to be applied in future to the hydrogen determination in Zircaloy cans. (INIS)

41442 LOW-TEMPERATURE PHASE TRANSFORMATION IN THE VANADIUM–HYDROGEN SYSTEM. Wanagel, J.; Sass, S. L.; Batterman, B. W. (Cornell Univ., Ithaca, N. Y.). Contract AT(11-1)-3164. Phys. Status Solidi (a); 11: No. 2, 767-70 (16 Jun 1972).

Electron microscope specimens containing β-vanadium hydride showed evidence for the occurrence of a low-temperature phase transformation. Upon cooling to a specific temperature in the range from 170 to 200°K, additional $\frac{1}{3}$-order reflections appeared which were shown to come from different regions than the β-hydride domains. The $\frac{1}{3}$-order reflections are consistent with $(10\bar{1})_{bct}$ planes of hydrogen atoms spaced $3d_{10\bar{1}}$ apart. (auth)

41443 STUDY OF RUPTURE STRUCTURE IN POLYCRYSTALLINE Nb SAMPLES UNDER TRACTION AT LOW TEMPERATURES (20 TO 300°K) USING SCANNING ELECTRON MICROSCOPY. Fries, J. F. (CEN de Saclay, Gif-sur-Yvette, France); Houssin, B.; Meny, L.; Cizeron, G. Metaux (Corros.-Ind.); 46: No. 554, 335-8(Oct 1971). (In French).

Changes in the rupture structure of four different purity Nb test pieces were studied using scanning electron microscopy. Various parameters such as the purity, the mean dimensions of the grains, the temperature during the testing, and the rate of deformation used were studied successively. After having calculated the rate at which the rupture area is reduced under various conditions, the various thermal evolution curves representing the area reduction are plotted. The ductile/brittle transition zones were localized in terms of the various parameters enumerated. A detailed comparative study of the different modes of rupture by optical microscopy, scanning electron microscopy, and conventional electron microfractography using direct carbon replicas is represented. The advantages of scanning electron microscopy over the other techniques are established. (France)

41444 PLASTIC DEFORMATION OF Ti AND Zr. Brehm, Claude (Compagnie Generale d'Electricite, Marcoussis, France); Lehr, Pierre. Metaux (Corros.-Ind.); 46: No. 554, 359-81(Oct 1971). (In French).

The effects of rolling and subsequent annealing on the preferred orientations of Ti and Zr in the form of metallic sheets (deformation and recrystallization textures) were established. The flow stress corresponding to a given elongation in the annealed state was, in every case, less in the rolling direction than in the transverse direction. The ductility was higher in the rolling direction. The tensile strength curves are represented by equations. Tensile deformation occurred, principally, by prismatic slip. The contribution of twinning was studied. Transmission electron microscopy was used to study the structure of work hardened Zr and Ti. The increase in the residual electrical resistivity produced by tensile deformation at room temperature varied with the degree of elongation and dislocation density. The deformation of Ti by rolling generated (for a given rate of deformation) a larger increase in resistivity than tensile stressing. (France)

41445 INFLUENCE OF MOLYBDENUM ON HIGH-TEMPERATURE CREEP OF NIOBIUM. Lazarev, E. M.; Ugaste, Yu. E. Probl. Prochnosti; No. 3, 54-6(1972). (In Russian).

Methods of measurement of long-term hot hardness, twisting, and extension were used to study the high-temperature creep of alloys of niobium with molybdenum (from 15 wt % Mo) in the 1,100 to 1,500°C temperature interval in a vacuum of approximately 5×10^{-4} mm Hg. The activation energy of high-temperature stable creep is determined and it is demonstrated that its value correlates well with the activation energy of diffusion in the niobium–molybdenum system. It is established that the dependence of creep rate of the alloys studied on stress is an exponential dependence. Results of experiments indicate that throughout the entire range of concentrations studied, alloying of niobium with molybdenum increases the creep resistance of the solid solutions. (JPRS)

41446 ORDERING OF HYDROGEN IN β–TANTALUM HYDRIDE. Wanagel, J.; Sass, S. L.; Batterman, B. W. (Cornell Univ., Ithaca, N. Y.). Phys. Status Solidi (a); 11: No. 2, K97-100(15 Jun 1972).

Electron diffraction was used to study the structure of β–Ta_2H. The reciprocal lattice symmetry was found to be the same as for β–V_2H, and the maximum point group symmetry of 2/m places the hydride structure in the monoclinic Laue group. (D.L.C.)

Radiation Effects

41447 (CONF-710342–13) IRRADIATION INVESTIGATIONS OF THE HEAVY SECTION STEEL TECHNOLOGY PROGRAM. Paper No. 14. Witt, F. J. (Oak Ridge National Lab., Tenn.). [nd]. 7p. Dep. NTIS.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

The HSST program for fast-neutron radiation effects on ASTM A533 Grade B, Class 1 steel and weldments is described. The objectives are to evaluate the effects of irradiation on the fracture behavior of pressure vessel steels and weldments and vessels fabricated from such steels and weldments, taken singly and in combination with in-service related factors such as fatigue, strain aging, stress corrosion cracking, and possibly other embrittling factors. It is anticipated that simulation of irradiation behavior will serve to provide a convincing understanding of the behavior of in-service vessels that undergo significant amount of irradiation in the core region. (P.C.H.)

41448 (CONF-710342–14) STATE OF COOPERATIVE EFFORTS BETWEEN THE HSST PROGRAM AND THE PRESSURE VESSEL STEEL IRRADIATION PROGRAM OF VEREIN DEUTSCHER EISENHUETTENLEUTE (VDEh). Paper No. 15. Sievers, G. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). [nd]. 7p. Dep. NTIS (U. S. Sales Only).

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

The effects of fast-neutron irradiation on three types of low alloy pressure vessel steels (Mn–Ni–Mo–V– and Ni–Cr–Mo–steel) were investigated. Tests of base metal, weld, and heat affected zone (HAZ) were conducted. The results of Charpy-V notch tests of weld metal and HAZ showed that the transition temperatures were approximately –60°C at 30 ft-lb. The values of the weld reached the ASTM requirements of class 2 while those of HAZ were well within class 1. (P.C.H.)

41449 (CONF-710342–16) · EVALUATION BY LINEAR ELASTIC FRACTURE MECHANICS OF RADIATION DAMAGE TO PRESSURE VESSEL STEELS. Paper No. 18. Mager, T. R. (Westinghouse Electric Corp., Pittsburgh, Pa.). [1970]. 12p.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

The irradiation of the two capsules containing 2T compact tension specimens was completed. The fracture toughness (K_{Ic}) properties were generated for A533, Grade B, Class 1 steel plate and submerged arc weldment material in the post-irradiation condition (2 to 6×10^{19} n/cm^2). Tensile properties were also generated for the plate material under the same conditions of neutron exposures. In addition, the post-irradiation fracture toughness from one test performed on A508, Class 2 steel was obtained. The results indicated that the post-irradiation fracture toughness properties were highly temperature-dependent, i.e., they exhibited the same transition temperature shift as the 30 ft-lbs "fix" Charpy transition temperature. (auth)

41450 (CONF-720420–6) SCIM, A THEORY-BASED COMPUTER CODE FOR THE PREDICTION OF THE IN-PILE BEHAVIOR OF TYPE 304 STAINLESS STEEL. Harkness, S. D.; Grappel, R.; McDonald, S. G. (Argonne National Lab., Ill.). 1971. 36p. Dep. NTIS.

From Conference on reactor materials performance; Richland, WA. (24 Apr 1972).

A model for the behavior of Type 304 stainless steel during fast-reactor irradiation was developed into the computer program SCIM (Swelling and Creep of Irradiated Metals). The model incorporates recent concepts on high-temperature radiation damage into an analytical tool for predicting in-pile behavior of Type 304 stainless steel. Swelling rates are discussed in terms of the relative efficiencies of voids and dislocations as sinks. The calculation for the swelling rate shows it is a maximum when the sink efficiencies are equal. The dose dependence of swelling is found to be a function of the relative rates of void and dislocation loop formation. Saturation mechanisms are discussed with respect to their effect on the swelling rate. Saturation is favored by increased void number density and increased irradiation temperature. This results in a compromise between irradiation temperature and the expected void volume at saturation. Cold work is expected to be increasingly effective with increasing irradiation temperature. At 372°C the dose dependence of swelling in cold-worked material is expected to be much higher than for solution-annealed material because of the rapidly changing relative effectiveness of voids and dislocations as point-defect sinks. High number densities of incoherent precipitate should limit swelling at intermediate irradiation temperatures by forming a saturation microstructure at low void volumes. A climb-controlled in-pile creep mechanism is discussed. The expression that results depends on the radiation-produced excess interstitial flux to glissile dislocations as the mechanism for enhanced in-pile creep. The glissile dislocations are created by the unfaulting of irradiation-produced interstitial dislocation loops. The principal obstacle is taken as dislocations pinned by the void structure. The maximum in-pile creep rate is expected to occur at nearly the same temperature at which swelling is a maximum. The creep rate is expected to slowly decrease with dose. (auth)

41451 (COO–3171-5) DOSE AND ORIENTATION DEPENDENCE OF RADIATION DAMAGE BY 200 kV ELECTRONS IN ALUMINUM. Chen, Yun-Hoo (Cornell Univ., Ithaca, N. Y. Materials Science Center). Oct 1971. Contract AT(11-1)-3171. 61p. Dep. NTIS.

In-situ electron displacement damage in single and polycrystalline aluminum films with ⟨100⟩, ⟨111⟩, and ⟨211⟩ beam orientations was investigated in a JEM 200 electron microscope operating at 200 kV. Damage characterized by black–white contrast was observed after 5 to 10 minutes of irradiation and grew to become dislocation loops upon further irradiation. A majority of the loops observed can be identified as interstitial loops. The growth characteristics of the interstitial loops were analyzed according to the kinetic model proposed by Brown, Kelly and Mayer. Calculations by this model give a reasonable value for the activation energy of impurity controlled interstitial migration, but result in overestimates of the defect retention efficiency and the width of the surface denuded zone. This discrepancy may be due to film surfaces acting as defect sinks and the mobility of vacancies at the irradiation temperature; both of these factors have not been considered in the kinetic model. The growth rate of the interstitial loops appeared to be controlled by surface acting as interstitial sinks at the early stage, and then by existing dislocation loops in the bulk of the specimen. Specimens irradiated with various beam directions clearly showed an orientation dependence of the total loop formation. It was observed that more loop area was formed in the ⟨100⟩ direction than the ⟨111⟩ direction. Maxima are observed at about 5° and minima at about 28° from these two symmetry directions. (auth)

41452 (HEDL-SA-161-S) NEUTRON FLUENCE EFFECT ON THE FRACTURE AND TENSILE PROPERTIES OF ASTM A 533 B PRESSURE VESSEL STEEL. Williams, J. A.; Hunter, C. W. (Hanford Engineering Development Lab., Richland, Wash.). [nd]. Contract AT(45-1)-2170. 9p. (CONF-710342-15). Dep. NTIS.

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

The specimens were irradiated at fluences of approximately 2 to 8 × 10^{19}n/cm^2 (E > 1 MeV) at 510 to 540°F. Results of tensile and fracture tests are presented in a series of curves. (J.R.D.)

41453 TRANSMUTATION-PRODUCED Mg_2Si PRECIPITATION IN AN IRRADIATED Al-2.5 PERCENT Mg ALLOY. Jostsons, A.; King, R. T. (Oak Ridge National Lab., Tenn.). Scr. Met.; 6: No. 6, 447-51(Jun 1972).

Results of experiments to study fast neutron effects on Mg_2Si production in 5052 Al-Mg alloy are presented. Postirradiation examination revealed that the alloy microstructure contained radioinduced dislocation loops ranging in diameter from 200 to 400 Å and spherical precipitate particles which were about 40 Å in diameter. The fine precipitate in the alloy was established as the transition phase β' by x-ray diffraction. The radioinduced β' precipitate and dislocation loops were found to produce large strength increases in the alloy as compared with unirradiated alloy specimens. (J.R.D.)

41454 ENERGY DEPENDENCE OF PROTON, DEUTERON, AND HELIUM-ION RADIATION DAMAGE IN SILVER, PLATINUM, AND GOLD. Andersen, H. H. (Danish Atomic Energy Commission, Roskilde. Univ. of Aarhus, Denmark); Soerensen, H. Radiat. Eff.; 14: No. 1-2, 49-66(May 1972).

The energy dependence of light-ion radiation damage was studied with Ag, Pt, and Au as target materials. The projectiles were 4 to 13 MeV p and d and 12 to 20 MeV ^{3}He and ^{4}He. As a measure of the damage introduced, changes in electrical resistivity were used. All measured damage-rate curves show strong saturation effects. The energy dependence is roughly E^{-1} lnE as expected from a Rutherford-recoil spectrum, but deviations from this behavior due both to deviations of the recoil spectrum from a pure Rutherford and to electronic energy losses of the recoil atoms are seen. Although a detailed quantitative fit to existing theories is not possible, several independent pieces of evidence indicate a substantially higher effective threshold displacement energy in gold than in platinum. (auth)

41455 THEORY OF DAMAGE PRODUCTION IN THIN TARGETS BY FAST PARTICLES OF LOW CHARGE. Schioett, H. E.; Thomsen, P. V. (Univ. of Aarhus, Denmark). Radiat. Eff.; 14: No. 1-2, 39-47(May 1972).

The theoretical description of radiation damage caused by MeV protons, deuterons, and α-particles in thin targets is revised with special emphasis on the reduction in damage production because of inelastic energy losses by recoiling target atoms. Corrections due to threshold effects and deviations from Rutherford scattering are also discussed. The expected damage is less (by up to a factor of two) than predicted by the Seitz theory and has a different energy dependence. A reasonable fit to various experimental results is obtained. (auth)

41456 CORRELATION BETWEEN CLEARED CHANNELS AND SURFACE SLIP STEPS IN NEUTRON IRRADIATED COPPER CRYSTALS. Sharp, J. V. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Eff.; 14: No. 1-2, 71-5(May 1972).

A technique utilizing electroplating is described for the preparation of specimens for transmission electron microscopy, which show the relation between surface detail and internal structure. The cleared channels in deformed neutron irradiated copper crystals were correlated with surface slip steps indicating that the surface slip bands are a true representation of the bulk deformation behavior. The slip steps show a uniform distribution of shear within the central region of the cleared channel, with a decreasing shear strain near the edges. The channel is, however, cleared of irradiation produced defects for approximately the full width of the slip step, indicating that the removal mechanism is relatively efficient. This and other features of the slip process are discussed in terms of the observations. (auth)

41457 HELIUM PRODUCTION IN THE STEELS 1.4988, 1.4981, AND 1.4970. Closs, K. D. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 17: No. 6, 315-16 (Jun 1972). (In German).

As cladding material for the fast sodium-cooled breeder reactor SNR, the stabilized austenitic steels 1.4988, 1.4981, and 1.4970 compete closely with each other. To obtain information about radiation behavior of these materials, extensive experiments were performed in the BR2 Reactors (Mol/Belgium), and DFR(Dounreay/Scotland). In addition to formation of pores and creeping, development of high-temperature brittleness was studied. Up to fast neutron doses of 10^{22} n/cm^2, all three steels produced helium amounts that were higher by a factor of 2 than those expected for the SNR. Because of the fact that, for the most part, helium is produced through the thermal reaction Ni-59(n,α) Fe-56, the experimental results gained in the BR-2, can be applied to the SNR with respect to high-temperature brittleness. (H.B.G.)

41458 SOME REGULARITIES IN THE SPUTTERING OF A THIN LAYER OF FISSIONABLE MATERIAL ONTO A METALLIC SUBSTRATE BY FISSION FRAGMENTS. Gorshkov, V. K.; Petrov, P. A. This paper was summarized in At. Energ. (USSR); 30: No. 1, 49(Jan 1971) as paper No. 461/5312. (In Russian).

Full copy of this paper is held by TIC.

As had been shown in an earlier article, sputtering of thin layers of fissionable isotopes onto metallic substrates (thin sources) is achieved through the action of fission fragments traversing the surface. The amount of emission depends on the topography of the surface of that layer. This topography undergoes some changes through the bombardment by the fission fragments, which acts to reduce emission from thin sources with increased radiation exposure dosage. The sources used for further research on these phenomena were in the form of thin layers of the spontaneously fissioning isotope ^{244}Cm coated onto different metallic substrates. It was found that emission by these sources on which the fission fragments impinged is completely restored through thermal annealing of the sources in the atmosphere and at normal pressure. The recovery temperature is related to the recrystallization temperature of the substrate material. On the basis of these and other experimental data, it is inferred that the decrease in the emission of the thin sources is brought about by fragments penetrating deeper into the metallic substrate. The thin layer of fissionable material coated onto the surface of the solid specimen may be acting, therefore, as a sensitive indicator of microscopic deformations in the surface of the material under investigation. In particular, a new method of investigating radiation damage in solid media becomes possible on that basis. The great sensitivity of the method makes it possible to conduct this research at low exposure doses and during the irradiation process, and also makes it possible to study the effects of radiation in their dependence on the state of the material under investigation. (auth)

41459 INFLUENCE OF NEUTRON IRRADIATION AT HIGH TEMPERATURES ON THE TIME-TO-RUPTURE AND CREEP BEHAVIOR OF AUSTENITIC STEELS. Boehm, H.; Wassilew, C.; Scheibe, W. (Kernforschungszentrum, Karlsruhe, Ger.). pp 420-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Changes of properties of austenitic steels 4961, 4981, and 4988 were evaluated after fast neutron irradiation in BR-2 at temperatures from 620 to 750°C. Possible influences on high-temperature embrittlement of appropriate mechanical-thermal preirradiation treatments for steel 4988 were examined. (INIS)

41460 HIGH-TEMPERATURE RADIATION EMBRITTLEMENT OF BORON-ALLOYED AUSTENITIC STEELS. Kaden, W.; Reiff, K.; Leitz, C. (Siemens AG, Erlangen, Ger.). pp 424-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The influence of boron additions on the ductility of austenitic steels at high temperatures has been studied. Applying the pure isotope ^{11}B as addition, the embrittlement which is known to result from He-bubbles caused by the nuclear reaction ^{10}B(n,α)^{7}Li, is avoided. The strain at failure is increased to twice the amount by addition of 50 ppM boron and irradiation. Results of metallographic studies show that transcrystalline fracture is favored as compared with intercrystalline fracture. Additions of 0.4% Ti instead of Nb also have a positive effect on the ductility. (INIS)

Other Materials

Refer also to abstract 42551.

41461 (CERN-72-7) SELECTION GUIDE TO ORGANIC MATERIALS FOR NUCLEAR ENGINEERING. Van de Voorde, M. H.; Restat, C. (European Organization for Nuclear Research, Geneva (Switzerland)). 17 May 1972. 139p. Dep. NTIS (U. S. Sales Only).

Data and information are presented on the properties of commercial organic materials used in accelerators. Data are also presented on radioinduced degeneration characteristics of these materials. (J.R.D.)

41462 THERMAL DIFFUSIVITY OF PYROLYTIC GRAPHITE AT HIGH TEMPERATURES. Tanaka, Takaho; Suzuki, Hiroshige (National Inst. for Research in Inorganic Materials, Tokyo). Carbon; 10: No. 3, 253-7(Jun 1972).

The thermal diffusivity of three pyrolytic graphites was measured using the modulating electron beam method over the temperature range from 1300 to 1900°C. One of the specimens was as-deposited at 2500°C, and the others were the same heat-treated at 3000°C after deposition. The mean free path of phonons was estimated by analysis of the experimental data. The mean free path seemed to be independent of temperature in the direction perpendicular to the deposition plane, being 4.8 Å for the as-deposited specimen, 6.4 and 7.4 Å for the two heat-treated ones, respectively. The temperature dependence of the mean free path parallel to the deposition plane could not be expressed in analytical form. However, a monotonic decrease from 91 Å at 1330°C to 56 Å at 1980°C was indicated by a tentative approximate calculation. (auth)

41463 DYNAMIC MECHANICAL PROPERTIES OF GAMMA-IRRADIATED STRESS-GRAPHITIZED PYROLYTIC CARBON. Blankenhorn, P. R.; Kline, D. E. (Pennsylvania State Univ., University Park). Carbon; 10: No. 3, 259-65(Jun 1972).

The dynamic mechanical properties of a ^{60}Co irradiated stress-graphitized pyrolytic carbon specimen were measured as a function of temperature from 80 to 750°K. The specimen received a range of gamma doses from 0.72 to 1400 Mrad. The dynamic elastic modulus, E′, values increased with dose at all temperatures. An inverse annealing peak in the elastic modulus was detected after 7 Mrad gamma irradiation. This corresponded to about 10^{-8} carbon atoms per atom displaced. Some evidence of the β (165°K), γ (340°K) and δ (440°K) internal friction, Q^{-1}, peaks was obtained after 140 Mrad. The β peak was clearly detectable after 1400 Mrad. The results are compared and discussed with regard to results of previous investigations involving reactor irradiations. (auth)

41464 RADIOLYTIC GRAPHITE/CO_2 REACTION: THE EFFECT OF CARBON MONOXIDE AT 225 TO 375°C. Best, J. V.; Dominey, D. A.; Wood, C. J. (Berkeley Nuclear Labs., Eng.). Carbon; 10: No. 3, 317-22(Jun 1972).

The effects of CO on the γ-radioinduced reaction between graphite and CO_2 were investigated at 225 to 375°C. G(−C) values were determined using a ^{14}C-labelled PGA graphite specimen for a range of CO concentrations from 10 vpM to 1.3%. The results agreed with those of others in areas of overlap and fitted a previous mechanism for CO inhibition. Equations for the dependence of G(−C) on CO concentrations at 375, 280, and 225°C were derived. The product ratio $^{14}CO:^{14}CO_2$ was not significantly affected by CO concentration, but increased with temperature. The mechanism of the radiolytic gasification of graphite by CO_2 is discussed in the light of these results. (auth)

41465 RUBBER AND PLASTIC HOSES IN NUCLEAR ENGINEERING. Schwenk, H. (Aeroquip GmbH, Hanover). Kerntechnik; 14: No. 4, 178-82(Apr 1972). (In German and English).

The makeup and engineering data of hoses, and the necessary tests, are described, including sketches illustrating the arrangement of the medium-carrying and pressure-carrying components of various types of hose. Application possibilities in various fields are discussed. Hoses present in certain applications have considerable advantages in comparison with rigid pipework lines. Standard hoses are available for various media and various applications. (auth)

41466 ELASTIC BEHAVIOR OF THE PIPE WALL FOR WATER-HAMMER APPLICATIONS. Safwat, Hemmat H. (Univ. of Tech., Delft, Netherlands). Nucl. Eng. Des.; 21: No. 1, 85-94(1972).

Strains in the pipe wall during transient conditions resulting from closure of a valve on a horizontal pipeline were measured. The measured strains were used together with transient pressure measurements to evaluate the elastic behavior of the pipe wall during such hydraulic transient conditions. The assumptions commonly used in the derivation of the continuity equation for water-hammer applications were investigated in view of the measurement results. (auth)

41467 VOLUME CHARGE IN A DIELECTRIC PRODUCED BY AN ELECTRON BEAM. Vorob'ev, A. A.; Evdokimov, O. B.; Tubalov, N. P. (Tomsk Polytechnical Inst., USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 12, 3116-17(Jun 1972).

Translated from Fiz. Tverd. Tela; 13: No. 12, 3691-2(Dec 1971).

Plexiglas disks were irradiated by electrons at 0.8, 1.0, and 1.2 MeV for 15 to 20 sec at 0.5 A/cm^2. The volume charge was probed using penetration by β particles. The relative change δ of the penetrating β particles was plotted vs time after irradiation. At 0.8 and 1.2 MeV, the sign of δ reverses after 2 to 4 days, indicating a change in sign of the effective charge. The charge reversal is probably due to an electric state in the Plexiglas. (D.L.C.)

41468 IMPROVEMENTS IN OR RELATING TO PHENOLIC RESIN BINDER FOR NUCLEAR REACTOR FUEL. Jenkins, Mansel John (to United Kingdom Atomic Energy Authority). British Patent 1,277,051. 7 Jun 1972. Filed 13 Jun 1969.

A binder is described for use in the production of coated particle fuel consisting of phenol, cresol and hexamethylenetetramine in the molecular proportions 10/4/1. This mixture is heated to form a resin, which is dissolved in a suitable solvent (isopropyl alcohol) and applied to graphite powder. Fuel particles, precoated with fission product-retaining material, are submitted to tumbling in a drum into which the graphite powder is introduced; the binder is softened by contacting the graphite powder with the solvent as the powder enters the drum, so that the fuel particles acquire an outer coating of graphite by a snowballing effect. The particles may then be compacted by cold pressing, followed by carbonization of the binder. (UK)

41469 VOIDS IN IRRADIATED U_3Si: EFFECT OF ELECTROPOLISHING. Hastings, I. J.; Rose, D. H.; Shipley, B. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater.; 44: No. 1, 87-90(Jul 1972).

U_3Si fuel swells during irradiation, with the volume change dependent on both temperature and burnup. The defects producing significant volume increases are voids 150 to 400 nm in diameter, possibly containing a small amount of fission gas. In practice the swelling is accommodated by providing free volume along the axis of the fuel element. In examining the voids by electron microscopy, a replication technique was used since the swelling was too great to permit thinning of foils for transmission work. As the surfaces were prepared by electropolishing, it was important to confirm that pore size distributions determined from the replicas were representative since sample preparation may change the character and size of the defects. Irradiated samples approximately 6 mm long by 1.5 mm square were measured by an immersion method and pore volume fractions calculated from the densities thus obtained. The samples were then mounted in a miniature vice, immersed in liquid nitrogen for several minutes and fractured. One of the resulting pieces was mounted on a glass slide and shadowed with commercially pure platinum at 10^{-7} torr. The source−specimen distance was 10 cm and shadowing angle 60°; carbon was deposited at 90° to form the replica. Dissolution of the U_3Si from the carbon coating was initially carried out in an aqueous 15% HNO_3 solution for 72 hr; the replica was finally floated clear in an aqueous 0.5% HF solution. The surface of the other fractured piece was electropolished for 15 min in stirred methanol-1% perchloric acid at −65°C and current density of 50 mA · cm^{-2}. This surface was also replicated as described earlier. In general, the surface preparation technique used for irradiated U_3Si had no significant effect on pore characteristics. Pore volume fractions and pore densities derived from electropolished surfaces compared closely with those from corresponding as-fractured surfaces. However, the possibility remains that some defects originally less than about 20 nm in diameter are enlarged by electropolishing. Also, pore shape in irradiated U_3Si is unchanged in electropolished samples. (R.C.K.)

41470 INVESTIGATION OF THE EFFECT OF NEUTRON IRRADIATION ON THE STRUCTURE OF PYROLYTIC CARBON COATINGS OF COATED FUEL PARTICLES. Koizlik, K.; Balthesen, E. (Kernforschungsanlage, Juelich, Ger.). pp 630-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The orientation anisotropy of a pyrolytic carbon coating represents one of the most essential factors for the assessment of coated particles with regard to their use in high temperature reactors. An optical procedure based on the phenomenon of bireflection of optically uniaxial crystals is well suited to the direct determination of the orientation anisotropy of the fuel particle coatings by studying their metallographic microsections. The measurements carried out yielded new results as to the influence of irradiation parameters such as neutron dose, burnup, and temperature on the orientation anisotropy. It was found that annealing time also and chemical composition of the fuel particle kernel affects the anisotropy of the coating. The anisotropy changes thus established are compared and coordinated with a qualitative model. (INIS)

41471 CONCRETE–POLYMER MATERIALS PROGRAM. Steinberg, Meyer (Brookhaven National Lab., Upton, N. Y.). Isotop. Radiat. Technol.; 9: No. 3, 319-21(Spring 1972).

Activities in programs to develop concrete–polymer materials for use in improved construction are briefly reviewed. The USAEC and a number of other U.S. government organizations are conducting research on these materials. (J.R.D.)

41472 MULTISTAGE POLYMERIZATION PROCESS WITH INDEPENDENTLY ADJUSTABLE RADIATION SOURCES. Ransohoff, Jackson A. (to Neutron Products, Inc.). U. S. Patent 3,666,645. 30 May 1972. Filed 1 Jun 1967.

Emulsions and solutions of monomer are catalytically polymerized by irradiation by circulating a monomer containing process stream through a radiation field in a first stage, removing the heat of polymerization while maintaining temperature control, feeding from the first stage into a second process stage which is similar in operation to the first stage but with a higher proportion of polymer, and operating the second stage at a predetermined temperature, and continuing the steps of irradiation, under conditions of good temperature control until the reaction is completed or substantially completed. The volume of reactants exposed to the radiation field or the radiation dose to which the various process streams are exposed is adjusted to control the polymer content of each stage and provide for a steady flow of reactants through the system. (Official Gazette)

41473 GAMMA-RAY INDUCED CONDUCTIVITY IN INSULATING POLYMERS. V. Okamoto, Shinichi; Furuta, Junichiro; Hiraoka, Eiichi. Annu. Rep. Radiat. Center Osaka Prefect.; 12: 78-80(1971).

Decay curves of polyethylene after irradiation are decomposed into 4 exponential decay components. Decay time constants for these components are independent of the ^{60}Co gamma dose rates. Using Fowler's model, the dose-rate dependence of the induced current during irradiation does not agree with the one estimated using decay curves after irradiation. By the use of our model it can be shown that the dependence of induced current on dose-rate obtained from growth curves is in good agreement with the one from decay curves at the dose-rate range of more than 5×10^2 R/h in this experiment. (auth)

41474 FORMATION OF γ-FORM CRYSTALS IN IRRADIATED POLYPROPYLENE Kojima, Morio; Mori, Kinya (Central Research Labs., Yokohama, Japan). J. Polym. Sci., Part A-2; 10: No. 6, 1171-4(Jun 1972).

Isotactic polypropylene was irradiated by ^{60}Co γ rays at doses up to 100 Mrad at the rate of 1 Mrad/h, melted, and γ-form crystals were grown from the melt. X-ray diffraction was used to study the structures formed under varying conditions: pressure, gel and sol fractions, and recrystallization in a state of fixed thickness or length. The formation mechanism is discussed; the α and γ forms of isotactic polypropylene are alike in the mode of crystal growth and cannot be differentiated by morphology. (D.L.C.)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

Refer also to abstracts 40939 and 42477.

41475 (AED-CONF-71-100-57) NONDESTRUCTIVE NUCLEAR MATERIAL ASSAY. Hille, F.; Linder, W.; Schneider, V. W.; (and others) (Alpha-Chemie und Metallurgie G.m.b.H., Leopoldshafen (West Germany)). [1970]. 13p. (CONF-710901-543). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A rational and objective nuclear material safeguards system requires, as a tool for material accountancy, nondestructive methods for fissile material assay. Thus, in the Federal Republic of Germany a variety of techniques are under development. A few existing instruments for plant application are described based on methods which have previously been demonstrated. The instruments discussed include: a calorimeter, slowing down spectrometer, and delayed neutron analyzer. In addition, feasibility studies and check measurements are reported on assay with Sb–Be neutrons and by neutron capture γ-ray spectroscopy. (auth)

41476 (GULF-RT-A-12028) APPLICATION OF PHOTO-INDUCED REACTIONS TO NUCLEAR MATERIALS SAFEGUARDS PROBLEMS. Quarterly Progress Report, October 1, 1971–December 31, 1971. Bramblett, R. L.; Costello, D. G.; Ginaven, R. O.; Naliboff, Y. D.; Rundquist, D. E.; Trimble, G. D. (Gulf Radiation Technology, San Diego, Calif.). 4 Apr 1972. Contract AT(04-3)-167. 51p. Dep. NTIS.

A description of the research and development work performed during the period October 1, 1971 to December 31, 1971, on techniques and applications of nondestructive measurement of nuclear materials is presented. The principal effort during the quarter was the integration and testing of the new barrel scanner and detector systems for the mobile assay system (GAMAS). Results are also given for a preliminary study of the passive assay of ^{233}U in the presence of ^{232}U and ^{232}Th. During the reporting period extensive discussions were held with representatives of the Idaho Operations Office on the data from the field operation of GAMAS at the National Reactor Test Station (NRTS). Their report is included as an appendix. It describes, in a different perspective, the work performed at NRTS by both GAMAS and the Isotopic Source Assay System (ISAS). It is felt that the careful statistical analysis and discussions that are presented from a different vantage point warrant distribution as an appendix to this report. (auth)

41477 (LA-DC-72-597) ^{252}Cf FUEL ROD ASSAY SYSTEM: IN-PLANT PERFORMANCE. Forster, R. A.; Smith, D. B.; Menlove, H. O. (Los Alamos Scientific Lab., N. Mex.). [1971]. 19p. (CONF-720528-1). Dep. NTIS.

From thirteenth annual meeting of the Institute of Nuclear Materials Management; Boston, MA. (31 May 1972).

The ^{252}Cf fuel rod assay system incorporates a 100 μg ^{252}Cf neutron source, moderator, and detector to nondestructively assay LWR fuel rods for fissile content. The system is relatively uncomplicated and can be operated by virtually anyone. Assay results are obtained immediately following the measurement with single assay precisions of 1.1 to 1.5% (1σ) of the ^{235}U content of the rod with an effective throughput rate of one rod per minute. The total assayed mass of more than 500 rods should have an uncertainty of less than 0.5% (2σ). In-plant experience, which includes more than 20,000 BWR and PWR fuel rod assays, has shown that the system is quite reliable. Modifications to the ^{252}Cf fuel rod assay system that will allow both a total fissile measurement as well as a rapid pellet-to-pellet fissile scan are described. A prototype of this modified system has been constructed and is currently being tested to evaluate pellet-to-pellet resolution and fuel rod throughput rates. (auth)

41478 (LA-DC-72-604) ASSAY EXPERIENCE WITH MONAL AT OAK RIDGE. Reilly, T. Douglas (Los Alamos Scientific Lab., N. Mex.). 1972. 33p. (CONF-720529-2). Dep. NTIS.

From thirteenth annual meeting of the Institute of Nuclear Materials Management; Boston, MA. (31 May 1972).

Operation of the Mobile Nondestructive Assay Laboratory (MONAL) at AEC facilities in Oak Ridge, Tenn. is described. The description serves to illustrate the techniques and services associated with the laboratory. Descriptions are included on scrap measurements, incinerator ash analyses, barrier and compressor blade measurements, acid leach residue analyses, process residue analyses, air filter measurements, effluent measurements, and cascade measurements. (J.R.D.)

41479 INTERNATIONAL CONTROL OF NUCLEAR MATERIAL. Morgan, F. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Atom (London); No. 188, 105-8(Jun 1972).

During the last two years international negotiations have produced a framework for a system of international agreement and control to monitor the production and peaceful use of both plutonium and enriched uranium. The previous attempts made since 1946 to restrict such production and use of nuclear material to non-military ends are outlined. The result of the present consultations, convened by the International Atomic Energy Agency, a document entitled "The Structure and Content of Agreement between the Agency and States required in connection with the Treaty on the non-proliferation of nuclear weapons", the so-called "Blue Bible", is considered. The principle differences from previous documents on this theme are discussed, namely: the setting out of principles of wider application, the consideration of national activities as a whole rather than as a series of isolated units, thus providing for a national system of accounting and control, the control of materials rather than facilities, and the limiting of the areas and frequency of access of inspectors unless there is a prima facie case for a closer scrutiny. Residual uncertainties are examined. (UK)

41480 OPTIMIZATION OF NUCLEAR SYSTEMS. Bouchey, Gary Don. Austin, Tex.; Univ. of Texas (1971). 245p. University Microfilms Order No. 72-15,715.

Thesis.

The mathematics of optimization is discussed and its application to problems in the area of nuclear science and engineering is demonstrated. Differential methods of optimization are described by use of the concept of constrained derivatives. Use of the constrained derivative is demonstrated through the solution of a problem which minimizes the cost of irradiation and counting of radioisotopes. The geometric programming algorithm for optimizing nonlinear functions with nonlinear constraints is described and solution methods are demonstrated through its application to simplified problems dealing with optimal shipping and storage of nuclear fuels, the optimal sampling from a container of special nuclear material, and the optimal geometry and composition of a nuclear reactor core. A number of numerical search algorithms are described and two examples of the use of such methods are formulated and solved. One deals with the optimal fitting of a theoretical neutron energy distribution to experimental foil activation data. The other minimizes the cost of a closed loop cyclic neutron activation system. The dynamic programming algorithm for the optimization of multistage systems is described. Example applications to nuclear type problems include the optimization of a nuclear materials safeguards sampling system and the optimal allocation of energy among the various processes in an industrial or an agro-industrial complex. (Diss. Abstr. Int., B)

41481 SAFEGUARDS MEASURES IN NUCLEAR FACILITIES OF THE FUEL CYCLE. Gupta, D.; Avenhaus, R.; Drosselmeyer, E.; (and others) (Kernforschungszentrum, Karlsruhe, Ger.). pp 650-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Safeguards measures and steps towards safeguards implementation are described along with relations between the various safeguards measures, optimization of expenditures (shipper-receiver-correlations, correlations within the cycle, application of random sample statistics), and cost of safeguards. (INIS)

41482 IAEA SAFEGUARDS APPLICATION TO NUCLEAR MATERIALS IN POWER REACTORS. Shmelev, V.; Gmelin, W.; Hough, G. pp 654-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A brief summary is presented of the main principles of material balance accounting after off loading of BWR's and PWR's and as applied to fuel cycles. (INIS)

41483 AUTOMATIC LEAD SPECTROMETER ARRANGEMENT FOR INSTRUMENTED SAFEGUARDS CONTROL. Krinninger, H.; Rupert, E. (INTERATOM, Bensberg, Ger.). pp 658-61 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The arrangement is to be employed at the end of the manufacturing process of a fuel rod fabrication plant. A survey is given of the important functions such as those associated with fraud safety, self-shielding, operational safety, and development of methods (optimum operation of the proton recoil counter tubes). (INIS)

Disposal and Storage

41484 (CONF-700974–, pp 44-5) FACILITIES FOR THE STORAGE AND DISPOSAL OF RADIOACTIVE MATERIALS AND WASTE. Crooks, R. N. (British Radiological Protection Association Ltd.).

From Conference on the design of laboratories for work with radioactive materials; Birmingham, England (18 Sep 1970).

The requirements of the UK Radioactive Substances Act are given in general terms. It is noted that reference must be made to individual certificates issued under the Act to ascertain the exact requirement with respect to particular premises. (J.R.D.)

41485 (ORNL–4776) RADIOISOTOPE-ORIENTED VIEW OF NUCLEAR WASTE MANAGEMENT. Rupp, A. F. (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 18p. Dep. NTIS.

Drawing upon a 25-year background in separating and packaging kilocurie quantities of fission products for isotopic power and radiation sources in the Oak Ridge National Laboratory Radioisotope Program, a system for the long-range management of high-level fission product waste is presented. This would involve an initial two-year storage of the liquid high-level waste to allow decay of about 70% of the radioactivity, followed by separation into chemically related groups, especially periodic group I-A (^{137}Cs) and II-A (^{90}Sr) (the principal remaining heat producers) and the remainder of the fission products plus the toxic, long-lived transplutonium isotopes. The lightly calcined, packaged residue is given an additional ten-year cooling period and is then chemically processed to remove uranium, plutonium and transplutonium elements, which are packaged and burned in a nuclear reactor; a small final unburnable residue of toxic nuclides is canned for permanent vault storage or sent to space. ^{137}Cs and ^{90}Sr are reprocessed after 50 to 75 years, and the undecayed portion is recycled. The low-radiation, low-toxicity bulk fission product residues are sent to low-level waste disposal. High decontamination factors are needed only on the final separations. Vault storage under surveillance on power park or power island premises is suggested to avoid hot shipments. The cost appears to be only moderately greater than for methods for unsupervised environmental storage. (auth)

41486 INJECTION OF INDUSTRIAL WASTES INTO THE SUBSOIL USING HYDRAULIC FRACTURING. Bertin, P.; Le Tirant, P.; Masson, M. Ann. Mines; No. 3, 7-28(Mar 1972). (In French).

Hydraulic fracturing has already been used in the USA for the disposal of radioactive wastes. The process is however, applicable to pollutants of any nature. The wastes are incorporated in a cement slag (to avoid any filtration of the injected fluids). The fluids are then injected into impermeable marl layers of the subsoil. When the cement hardens, a new stratigraphic layer is produced. Fractures developing in the impermeable layer must be horizontal. The initiation pressure, and the geometry and control of the extension of a horizontal fracture were studied. The possibility of using such systems in France is considered. The equipment used in constructing the wells, and at the surface is presented. The initial and operating costs of the system are discussed. (France)

41487 OPERATION OF THE FACILITY FOR DEEP BURIAL OF LIQUID RADIOACTIVE WASTES. Bagretsov, V. F.; Zakharov, S. I.; Metal'nikov, S. V. This paper was summarized in At. Energ. (USSR); 31: No. 2, 137-8(Aug 1971) as paper No. 517/6065. (In Russian).

Full copy of this paper is held by TIC.

The preliminary results of the operation of a test-industrial facility for the disposal of deactivated radioactive solutions in deep formations of the earth were communicated in 1967. An analysis of the performance of the facility during the period 1967 to 1969 shows that the initial solutions before burial can be prepared according to one of the following schemes: filtration, lowering of pH to 6 to 7; an increase of pH to 11.5, setting, filtration, and lowering pH to 6 to 7; addition of 3.0 mg-eq/liter calcium, an increase of pH to 11.5, setting, filtration, and lowering pH to 6 to 7; for solutions with a high content of surface-active substances (SAS) it is necessary to add, besides calcium, magnesium (up to 1.5 mg-eq/liter). The last scheme was not used in 1969, since the content of SAS was reduced by a factor of two to three in comparison with the initial period. Accordingly, in 1969 the specific expenditure of reagents (acid from 48 to 10.4 g-eq/m^3, calcium from 3.15 to 1.5 g-eq/m^3) and the quantity of pulp assigned for storage in bulk decreased in 1969 in comparison with 1966. The main equipment of the facility except the filters, which were cemented by suspensions after six to seven months of operation, functioned normally all these years. For restoring the filtering capability of the charge it was necessary to regenerate the filters with 5% nitric acid solution (consumption of acid 5 m^3 per 1 m^3 sand) twice a year. After the disposal of 290 thousand m^3 solutions the pressure at the mouth of the hold reached 57 atm while its pickup was probably caused by hydrodynamic factors as well as by silting of the end face zone by soft particles left in the solution. The most efficient method for controlling the extension of solutions disposed in a reservoir is γ-logging in observational holes. This method cannot be recommended as yet for a qualitative estimate of the filling of the reservoir due to the variability of the specific radioactivity and the radiochemical composition of the disposed solutions. Observations show that the solutions extended from the blower hole to 500 to 600 m in northwest and southeast directions. A radiochemical analysis of samples of stratified water showed that its activity is mainly due to ^{90}Sr, ^{137}Cs, and ^{106}Ru. (auth)

41488 TRIAL STORAGE OF LOW-LEVEL RADIOACTIVE WASTES IN THE SALT-MINE ASSE AND THE ACCEPTANCE CONDITIONS WITH RESPECT TO THEIR ROUTINE STORAGE. Kuehn, K.; Albrecht, E. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Munich). pp 613-17 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The Asse salt mine receives all radioactive wastes, not designated for further processing, from nuclear centers, industry, and nuclear power plants in Germany for final storage. The experience gained from 1967 to 1971 led to the formulation of a code of conditions for the storage of low-level radioactive wastes in the Asse mine. (INIS)

Handling Equipment and Procedures

Refer also to abstract 41013.

41489 (ARH–2468(Rev.)) REDEFINED CRITICALITY RISK CATEGORIES FOR FIRE FIGHTING. Blyckert, W. A.; Carter, R. D.; Ridgway, K. R. (Atlantic Richfield Hanford Co., Richland, Wash.). 10 Apr 1972. Contract AT(45-1)-2130. 9p. Dep. NTIS.

Following a serious Rocky Flats Plant fire in May 1969, automatic sprinkler systems were installed in several facilities where in the past, the use of water was considered a last resort in fire control. Since automatic sprinklers supply an unknown volume of water to a system as compared to manually controlled sprays, the criticality control parameters in a number of locations were reviewed, and the four criticality risk categories for fire fighting were redefined for the special conditions imposed by automatic sprinkler systems. These categories are: (A) for no probability of criticality if water is added; (B) for minimal probability of criticality if water is added; (C) for finite probability of criticality if water is added; and (D) for high probability of criticality if water is added. These new definitions clearly show where the addition of unlimited amounts of water can safely be used in fire fighting and that Category D locations should be eliminated in unshielded areas. (L.C.L.)

41490 (Y-DR-83) CRITICAL THREE-DIMENSIONAL ARRAYS OF NEUTRON INTERACTING UNITS. PART III. ARRAYS OF U(93.2) METAL SEPARATED BY VARIOUS MATERIALS. Magnuson, D. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 15 May 1972. Contract W-7405-eng-26. 9p. Dep. NTIS.

Polyethylene-reflected, 8-unit arrays of U(93.2)-metal cylinders having plywood, Celotex, Foamglas, and borated plastic foam between the fissile units have been assembled to delayed criticality. Calculations of k_{eff} using the KENO Monte Carlo code and Hansen-Roach 16-group cross sections are in satisfactory agreement with the experimental values. (auth)

41491 GRIPPER TYPE LINEAR MOTION DEVICE. (to Combustion Engineering Inc.). British Patent 1,275,517. 24 May 1972. Priority date 18 Jun 1969, United States.

A linear motion device for control and movement of shafts is described which is operated by magnetic coils and movable slugs of magnetic material. The slugs are used to move grippers in and out of contact with the shaft to effect control of the shaft. The magnetic field is used to move the slugs predetermined distances.

The device can be used to position reactor control rods by a series of rapid small steps. (J.R.D.)

41492 GASTIGHT SEAL FOR TWO CONTAINERS. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,276,395. 1 Jun 1972. Priority date 28 Jun 1969, Germany.

A closure consisting of parts easy to produce, easy to operate remotely, and sufficiently safe for use with containers such as gloveboxes is described. The closure consists of a gastight seal for two containers, the seal having two closure covers adapted to be clamped together. One container supports a collar which projects into an opening against the inside surface of which an associated closure cover and against the outside surface which the other container is adapted to be pressed with interposition of packing. The second closure cover is pressed against a selected one of the two packings by clamps. (J.R.D.)

41493 IDENTIFYING DEVICE FOR SPECIMEN CONTAINERS CONTAINING RADIOACTIVE SUBSTANCES. Soini, Erkki Juhani (to Wallac Oy). U. S. Patent 3,662,706. 16 May 1972. Filed 17 Jan 1969.

A device for identifying sample bottles, such as bottles containing radioactive substances, is described. The device has the shape of a cap which is placed upon the regular bottle cap the top of which carries a vertical tag-like member. The tag-like member has perforations extending therethrough and arranged to provide positive identification of the contents. (Official Gazette)

41494 CRITICALITY STUDIES OF SINGLE AND MULTIPLE SPHERICAL SYSTEMS. Dwivedi, S. R.; Singh, R. Shankar (Bhabha Atomic Research Centre, Trombay, India). pp 169-77 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

The accuracy in predicting the criticality of individual spherical plutonium systems and its dependence on the number of energy groups and the angular detail used in multigroup diffusion and transport theory calculations were studied. The interaction of multiple systems was studied using a modification method mainly based on the unified theory of interaction but treating the geometric interactions more accurately using Clark's approach and the results are compared with experimental values for a 3 × 3 array of uranium spheres. (auth)

41495 DEVICE FOR INDICATING SAMPLE VESSELS CONTAINING RADIOACTIVE MATERIALS. Soini, E. (to Wallac Oy). Finnish Patent 42,508. 10 Aug 1970. (In Finnish).

A device was invented to indicate sample vessels containing radioactive materials. In the device there is a component like a visor with a coding system by which it is possible to individualize the sample. The indicating device is formed by a capsule which is pressed on the disposable closing device of the sample bottle or vessel when the visor has been placed vertically on the upper side of the capsule. (Finland)

41496 MIXING DEVICE FOR POWDERY NUCLEAR FUELS. Beisswenger, H. (to ALKEM-Alpha-Chemie und Metallurgie). Canadian Patent 896,401. 28 Mar 1972. Priority date 5 Oct 1968, Germany.

A pair of elongated, co-axial hollow cylinders, with the diameter of the inner cylinder more than half the diameter of the outer cylinder, have a space between them defining a mixing chamber. The inner cylinder is equipped with blades on its outer wall for mixing the powdery fuels. The outer cylinder can be formed of two half shells to facilitate cleaning, and is pivoted for rotation about its own axis. The inner cylinder can be filled with neutron-moderating and -absorbing material. (Canada)

41497 AMERICIUM CONTAMINATION INCIDENT IN A NEW YORK STATE HEALTH DEPARTMENT LABORATORY. Whalen, Robert P.; Davies, Sherwood (New York State Dept. of Health, Albany). Radiat. Data Rep.; 13: No. 4, 249-53(May 1972).

The history of an ^{241}Am contamination incident in the New York State Health Dept. Laboratory, the equipment and methods used to discover the source of this contamination, the decontamination methods employed when the source was located, and the continuing medical investigation of the effects of the exposure on the man and his family who unknowingly had possession of contaminated material are described. (L.C.L.)

Transportation

41498 (DPSPU-72-124-2) SAFETY SUMMARY REPORT: LP-12 TRITIUM CONTAINER (PACKAGING OF RADIOACTIVE AND FISSILE MATERIALS). Final Report. Scaggs, R. A. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). May 1972. Contract AT(07-2)-1. 43p. Dep. NTIS.

Elemental tritium is shipped at low pressure in an insulated container in compliance with regulations set forth in Department of Transportation, Title 49, parts 173-178. The package is not a radiological hazard under normal or hypothetical accident conditions. (auth)

41499 (DPSPU-72-124-4) SAFETY SUMMARY REPORT: ^{238}Pu OXIDE SHIPPING CASK (PACKAGING OF RADIOACTIVE AND FISSILE MATERIALS). Final Report. Scaggs, R. A. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). May 1972. Contract AT(07-2)-1. 60p. Dep. NTIS.

Plutonium-238 (as PuO_2 powder) is shipped in triple-containment stainless steel shipping casks which are in compliance with AEC Manual Chapter 0529 (AECM 0529), "Safety Standards for the Packaging of Radioactive and Fissile Materials." (auth)

41500 (GULF-GA-A-10890) ANALYSES OF A SHIPPING CASK (MODEL FSV-2) FOR TRANSPORTATION OF MIXED FISSION PRODUCTS. Reeser, H. G. (Gulf General Atomic Co., San Diego, Calif.). 28 Apr 1972. Contract AT(04-3)-633. 115p. Dep. NTIS.

The Model FSV-2 shipping cask was analytically evaluated to ascertain compliance with applicable government regulations regarding packaging and transportation of radioactive materials. This document forms the basis for an application to obtain a U. S. Department of Transportation shipping permit. On the basis of the calculations contained in this document, it is concluded that the FSV-2 shipping cask does comply with all relevant existing government regulations. (auth)

PARTICLE ACCELERATORS

Design, Development, and Operation

Refer also to abstract 41746.

41501 (EUR-4753) DESIGN AND CONSTRUCTION OF A 100-keV ION ACCELERATOR FOR IMPLANTATION STUDIES. Cappellani, F. (ed.) (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 9 Nov 1971. 74p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 100.-.

Main features of the machine are the following: (1) ion energy to 100 keV for singly ionized atoms; high voltage split in two steps one before and one after the magnet to ensure at least 25 keV extraction potential independently of the energy of the ions on the target; (2) ion current delivered by a Nielsen source; current intensity of the order of $500/\sqrt{M}_\mu A$; (3) analyzing magnet of sector type with an angle of 127° and radius of 60 cm; double focusing both in the vertical and horizontal plane is provided by means of diverging poles; (4) target chamber provided with facilities for implanting at room temperature, high (800°K) and low (100°K) temperature, and for bombarding in channeling conditions; and (5) a beam sweeping system allowing to scan the beam across the target in the vertical and horizontal direction to obtain uniform ion implanted distribution. Detailed characteristics of the accelerator parts are given with experimental results obtained in the machine set up. Methods and computing programs developed for ion trajectories used in the design of the accelerator are presented. (auth) (France)

41502 MAGNETIC SYSTEM OF A SUPERCONDUCTING 50 MeV ISOCHRONOUS PROTON CYCLOTRON. Sarkisyan, L. A. This paper was summarized in At. Energ. (USSR); 30: No. 5, 452(May 1971) as paper No. 496/6073. (In Russian).

Full copy of this paper is held by TIC.

Topics relating to the development of a magnetic system for a superconducting isochronous cyclotron accelerating protons to 50 MeV at a field level $H_0 = 50$ kOe at the center, and beam extraction features, are discussed. The salient features of the accelerator are: 1) dependence of superconductor current on external field in cross section of the coil which will bring about current limitations; 2) relatively low fill factor of the coil cross section enclosing the superconductor (~20%); 3) difficulties in shaping a field to within $\pm 5 \cdot 10^{-4}$ error, since the transition to superconductivity brings about a reduction mainly in the radial dimensions of the machine; 4) presence of internal windings, in addition to the external winding, thereby limiting the current flowing through the windings. When these requirements are taken into account, the shaping of the center field and of the fundamental harmonic of the field can be achieved with the aid of nine concentric windings (basic winding and eight correction windings) and a flat harmonic winding (NbTi conductor). All the windings are placed within a single cryostat. Analysis showed that spatial field variation with high helicity should be used in order to achieve axial stability of the particles in the accelerator, rather than azimuthal field variation. The basic accelerator parameters assigned were: $H_0 = 50$ kOe, number of spirals 3, parameter of Archimedean spiral 4 cm, frequencies of betatron oscillations $0 \leq Q_Z \leq 0.2$, $1 \leq Q_2 \leq 1.066$, final acceleration radius 20 cm (radius for field shaping 22 cm). When the field is shaped in the median plane of the accelerator, attention is given to the field distribution throughout the cross section of the windings, so that the calculated current values will not exceed the critical values. The beam power in the accelerator may be ~50 kW at the final radius. A method involving introduction of a local inhomogeneity of the magnetic field at a finite radius is discussed as a means of maximizing beam extraction efficiency, and makes it possible to lower the frequency of radial betatron oscillations $Q_r = 1.066$ to unity. The frequency Q_Z increases to 0.33 in the process. The parameters of the flat superconducting (Nb_3Sn) winding shaping the required gradient of ~3000 Oe/cm were determined. This projected superconducting isochronous cyclotron will constitute a compact low-cost source of multiply charged ions and polarized particles with smooth energy control, and the use of high magnetic fields ($H_0 \geq 50$ kOe) in accelerators at low energies and medium energies will make it possible to increase beam intensity several times. (auth)

41503 SOME EXPERIENCES WITH A LINEAR ACCELERATOR. Bonazzo, E. Met. Ital.; 63: No. 8, 405-8; 415(Aug 1971). (In Italian).

A concise description of the x-ray apparatus operation principles follows a quick look at the main reasons (with particular reference to the exceptional exposure time shortness) related to the linear accelerator choice (6- to 10-MeV electron linac). The safety system characteristics are reported with some results showing the negligible dose rates found all around the protection bunker. Some diagrams show the results obtained from an experimental set of tests carried on in view of ascertaining the radiographic sensibility. (auth)

Auxiliaries and Components

Refer also to abstract 41505.

41504 SHIELDING OF HIGH-ENERGY ACCELERATORS: A REVIEW. Srikantiah, G. (Indian Inst. of Tech., Kanpur). pp 71-94 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

Topics include basic problems of high energy particle shielding, review of some experimental data, shielding calculations, materials used for shielding, and design details of some accelerator shields. (W.H.K.)

Ion Sources, Injection, and Extraction

41505 (LA-4961) BEAM MEASUREMENTS ON THE HIGH-INTENSITY PROTON INJECTOR OF LAMPF. Stevens, R. R. Jr.; Palermo, S. D.; Paciotti, M. A.; Mueller, D. W.; Mills, R. S.; Meyer, E. A.; Kohl, D. K.; Goplen, B. (Los Alamos Scientific Lab., N. Mex.). May 1972. Contract W-7405-eng-36. 35p. Dep. NTIS.

Pepper pot and quartz plate measurements were made near the exit of the accelerating column over a wide range of operating parameters. Phase space envelopes were accurately determined; however, density distributions are still in doubt. (auth)

41506 EFFECT OF A MAGNETIC FIELD ON THE LUMINANCE OF THE IMAGE OF THE CROSS-OVER OF A POSITIVE ION SOURCE EXCITED BY A HIGH FREQUENCY VOLTAGE. Degeilh, Andre; Gessinn, Guy; Pilod, Pierre; Zanchi, Gerard (Univ., Toulouse). Compt. Rend., Ser. B; 274: No. 8, 562-5 (21 Feb 1972). (In French).

The effect of a magnetic field on the luminance L′ of the image O′ of the crossover of an h−f source operating with argon was studied. The application of a transverse magnetic field across the ionization chamber enables values of L′ higher than those obtained with or without a longitudinal magnetic field to be obtained. The normalized luminance of O′ is of the order of 2.10^{11} $A \cdot m^{-2} \cdot sr^{-1}$ under optimum operating conditions ($V_{ext} = 6$ kV, $B_T = 39.10^{-4}$T). (France)

41507 SOURCE OF VERY INTENSE SHORT DURATION ELECTRON PULSES. Alpern, Marc; Jego, J. M.; Ternaud, Alain (to Commissariat a l'Energie Atomique). French Patent 2,076,604. 20 Sep 1971. Filed 21 Jan 1970. (In French).

A very intense short duration electron pulse source is described. It consists of a very fast light source and an evacuated enclosure enclosing a photocathode (possibly movable) and optoelectronics having high temporal resolution and small transit time dispersion. The optics are provided with a device, which enables the field applied to the photocathode to be varied. A window transparent to the light emitted from the source is mounted in the enclosure between the source and the photocathode, the electron source providing a focused electron beam capable of producing secondary emission. (France)

41508 DOUBLE CELL HIGH INTENSITY ION SOURCE. Luce, John S. (to Secretary of the Air Force). U. S. Patent 3,663,852. 16 May 1972. Filed 1 Apr 1970.

A system for generating high current density charged particle beams is described. The system includes a plurality of high intensity ion sources in combination with two charge exchange cells aligned linearly with one another. The ions are converted from one type of charge to an opposite charge in two stages. In the first stage, several beams of positive ions, for example, derived from a plurality of positive ion sources are beamed into a charge exchange cell and converted into neutrals. The several beams of neutrals from the first cell are then directed into a second charge exchange cell where the neutrals are converted into negative ions. (auth)

41509 IMPROVEMENTS IN OR RELATING TO NON-THERMIONIC CATHODE GLOW DISCHARGE DEVICES. Maskell, Clifford William Alfred (to United Kingdom Atomic Energy Authority). British Patent 1,275,261. 24 May 1972. Filed 4 Jun 1968.

Reference is made to devices for producing electron beams. The device described comprises an envelope, with means to maintain its gas filling at a predetermined pressure, and containing a cathode and a control electrode, together with an anode located within or forming part of the envelope. The cathode has a concave electron emissive surface. In operation electrons are emitted from the concave surface of the cathode as a focused beam, and focus adjusting means are provided by the control electrode. A third electrode, constructed of wire mesh, may surround part of the cathode, maintained at a potential positive with respect to the cathode, to minimize unwanted electron emission from the cathode. Various designs of electrodes are described. (UK)

41510 MULTIPLE BEAM AND WIDE BEAM ION SOURCES. Fitch, R. K.; O'Shea, K. R.; Rushton, G. J. (Univ. of Aston, Birmingham, Eng.). J. Phys., E (London); 5: No. 7, 622-3(Jul 1972).

Two modified forms of a new type of electrostatic ion source are described. The one produces multiple beams of positive ions and in the other a wide ion beam is produced. The sources can be used for ion etching either a large number of small specimens or a large area specimen. (auth) (UK)

41511 ENHANCING EFFECTIVENESS OF SYNCHROTRON CAPTURE IN BEAM BUNCHING OUTSIDE OF SEPARATRIX. Gurov, G. G.; Myae, E. A.; Pashkov, P. T.; Yakovlev, K. A. This paper was summarized in At. Energ. (USSR); 30: No. 4, 388 (Apr 1971) as paper No. 484/5888. (In Russian).

Full copy of this paper is held by TIC.

Results of calculations and experimental data on increases in the coefficient of synchrotron capture of particles in the accelerator of IFVE [High-Energy Physics Institute] are presented. The nonlinear MN-7 analog simulation computer was used in the calculations. Numerical data on bunching time and the parameters of the radio-frequency program were obtained, and the qualitative pattern of the capture process is examined in relation to cases of beam injection above and below the separatrix. The rapid phase shift in the accelerating field needed to bring about particle capture experimentally was attained by introducing controlled amplitude and pulse width into the pattern of variation of the ejection frequency. Frequency deviation was measured by a broadband frequency discriminator which was supplied with a signal proportional to the sum of the voltages of the resonators in the accelerator stations. The calculations and the results of experimental investigations indicate that synchrotron capture effectiveness can be improved well beyond that attainable by injection into a steady-state separatrix, when the IFVE accelerator is operated at medium intensity levels (up to $7 \cdot 10^{11}$ protons/pulse). A considerable increase in capture effectiveness can be achieved by this method even at the limiting accelerator intensity, it would seem, if the parametric resonance bands are properly corrected. (W.H.K.)

Ion Optics and Field Calculations

Refer also to abstract 42306.

41512 (FRNC-TH-175) PHASE PROBLEMS IN AN ELECTRON LINEAR ACCELERATOR. Lheritier, Lucien (Paris Univ., Orsay (France). Faculte des Sciences). [nd]. 383p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The performance of linear accelerators used in high energy physics depends upon the current-energy spectrum resolution; the latter being linked to the stability of the phase of the accelerating wave relative to the central electron of the packet. Unwanted modulations and distortions affecting the initial phase properties of the accelerating wave along the accelerator and in the auxiliary equipment are studied. The origin and the way in which such modulations are generated are analyzed for all power levels in the transmission system, the most probable recurring events and the random characteristics associated with the amplitude and frequency noise inherent in amplifiers being of particular concern. As the distortions are linked with the parasitic wave transformation modes (guided propagation, amplification, etc...) they are analyzed for the case of typical imperfections in the transmission characteristics such as: nonlinearity, phase-frequency dispersion of certain quadrupoles, mismatching due to changes in the propagation mode, transfer across the filtering quadrupoles, harmonic distortion, etc. Various developments in existing accelerators and developments required for a power increase leading to a final energy of 2.3 GeV are presented. (France)

41513 (INR-1369) BEAM DYNAMICS IN THE PROTON LINEAR ACCELERATOR 10-MeV ANDRZEJ. Sura, Jozef (Institute of Nuclear Research, Warsaw (Poland)). 1972. 154p. (In Polish). Dep. NTIS (U. S. Sales Only).

The basic theory of the accelerating and focusing structure of the proton linear accelerator ANDRZEJ is given. The basic parameters of the accelerating structure are determined in the single particle approximation for $g/L = \text{const} = 0.25$. The parameters of the focusing channel are determined for a zero proton beam and for an intensive beam in the approximation of uniform charge distribution in the beam cross-section for $\cos \mu = 0.45$. (auth)

41514 CALCULATION OF PHASE FOCUSING OF INTENSE BUNCHES OF CHARGED PARTICLES IN A DIRECT ACTION ACCELERATOR. Avramenko, M. I.; Kuznetsov, V. S.; Kuznetsova, N. P.; Nikol'skii, M. A.; Fidel'skaya, R. P. At. Energ. (USSR); 32: No. 5, 437-40(May 1972). (In Russian).

In connection with the spectrometry of fast neutrons and the achievement of nanosecond pulses in low-voltage neutron generators, electrostatic generators, and other accelerators, the discharge of so-called direct current generators was studied. An ion beam from a focused system was interrupted, and the 20- to 30-nanosecond cluster produced in the buncher was significantly shortened in duration during flight along the remainder of the track of the accelerator. Thus, phase focusing of the beam occurred. It was shown how the change in other parameters changed the duration and configuration of the cluster. (2 figures) (K.S.W.)

41515 PARTICLE TRAJECTORIES IN AN ISOCHRONOUS CYCLOTRON IN THE PRESENCE OF ACCELERATION. II. Khokhlov, Yu. K. This paper was summarized in At. Energ. (USSR); 30: No. 5, 451(May 1971) as paper No. 494/5913. (In Russian).

Full copy of this paper is held by TIC.

Time and spatial oscillations of a particle moving in the median plane of a cyclotron are studied. Ideal trajectory equations for the position of a particle of momentum p are given, and the linearized equations of motion outside the slits are solved in terms of generalized amplitudes and phases in Floquet theory extended to the case of quasiperiodic motion. An estimate for the logarithmical growing term is given. (W.H.K.)

41516 CRITICAL CURRENT IN AN ACCELERATING WAVEGUIDE WITH RADIAL SLITS PROVIDED IN DISCS. Orlov, A. K. This paper was summarized in At. Energ. (USSR); 30: No. 5, 451-2(May 1971) as paper No. 495/5958. (In Russian).

Full copy of this paper is held by TIC.

The maximum charge which can be accelerated in a conventional linear accelerator is limited by the "current-pulse contraction effect" which results from the excitation of a hybrid EH_{11} mode in the waveguide. The hybrid mode can be suppressed with the aid of radial slits provided in discs. Experiments have shown that this method helps to increase several times the accelerated charge. The results of a theoretical investigation of the properties of the EH_{11} wave in a waveguide provided with slits in discs are given. The critical current was calculated. The electrodynamic properties of the waveguide were analyzed with the method of partial areas, leading to the dispersion equation. The results were used to determine the critical current in the sections of a 2 GeV accelerator. (W.H.K.)

41517 CALCULATION OF LOW-CURRENT BEAMS IN DIRECT-ACTION ACCELERATORS. Fidel'skaya, R. P. This paper was summarized in At. Energ. (USSR); 30: No. 1, 51 (Jan 1971) as paper No. 464/5796. (In Russian).

A treatment of the formation of low-current beams in direct-action accelerators taking into account the finite phase volume and relativistic effects is given. An analytic solution is found for the equation for the envelope of a beam with a finite phase volume for the case of a uniform electric field E. This equation is used to derive the basic equations for the optics of low-current direct-action accelerators, which are valid for both ionic and electronic (relativistic) beams. Equations are obtained for the minimum beam radius and the corresponding distance from the entrance to the tube for given values of the radius, the electric field potential, and the beam convergence angle at the entrance to the tube. (W.H.K.)

41518 ANALYSIS OF THE INTERNAL STRUCTURE OF NONLAMINAR, AXIALLY SYMMETRICAL, HIGH-INTENSITY, CHARGED-PARTICLE BEAMS. Kuznetsov, V. S.; Bogdanova, V. I.; Komarow, O. L. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 16: No. 8, 1368-74(Aug 1971).

Translated from Radiotekh. Elektron.; 16: No. 8, 1476-83 (Aug 1971).

A statistical method of nonlaminar beam analysis is proposed. A system of equations, describing the internal structure of nonlaminar beams of charged particles, is derived. A nonlaminar beam model with nonzero azimuthal velocities is considered and it is shown that such a model describes the properties of real beams much better than nonlaminar models with zero azimuthal velocities. The results of specific calculations of the internal structure of a high-intensity nonlaminar beam, focused by a uniform longitudinal magnetic field, are presented. (auth)

Experimental Facilities

Refer also to abstract 41768.

41519 (BNL-16916) CHARACTERISTICS OF MESB DESCRIPTION FOR USERS. Fox, J. D.; Murphy, C. T. (Brookhaven National Lab., Upton, N. Y.). 10 May 1972. 31p. Dep. NTIS.

The medium energy separated beam (MESB), a one-stage, dc separated beam from the AGS external proton beam target B, designed to purify K's up to 6.0 GeV/c and $\bar{p}$'s up to 9.4 GeV/c for electronic experiments is described. The layout and optics, target design, fluxes, purity, spot sizes at final focus, momentum distribution at the final focus, momentum determination, and collimators are discussed. (W.H.K.)

41520 (CEA-N-1527) AUTOMATIC CONTROL OF THE APPARATUS USED IN PHOTONUCLEAR EXPERIMENTS. Daujat, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1972. 35p. (In French). Dep. NTIS (U. S. Sales Only).

The automatic control of the apparatus used in a series of photonuclear experiments of the (γ,xn) type with the 70-MeV linac at Saclay (France) is described. The overall control is performed by a PDP 8 I computer through a system of correctly adapted interfaces. Thus, a given set of experimental parameters in the electromagnetic guidance, in the neutron detecting and in the linac beam-current control systems is constantly checked and corrected. A specific example of such a control is also given. (France)

41521 (GIPR-24) SYSTEM FOR ION COLLECTION STUDIES. Kugler, E. (Chalmers Tekniska Hogskola, Goteborg (Sweden). Institutionen for Fysik). Feb 1970. 15p. Dep. NTIS (U. S. Sales Only).

A system for noble gas ion collection studies by means of a radioactive tracer method is described in detail. Ions from an electromagnetic isotope separator are trapped in target surfaces under ultra-high vacuum conditions. A goniometer allows measurement of the dependence of ion trapping on the angle of incidence. Results are presented of Kr^+ trapping measurements at 40 keV energy in polycrystalline copper. (auth) (Sweden)

41522 (KFKI-72-31) INVESTIGATION OF TRITIUM CONTAMINATION ON TITANIUM ION-GETTER PUMPS. Biro, J. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Apr 1972. 7p. (CONF-720503-4). Dep. NTIS (U. S. Sales Only).

From second European congress on radiation protection; Budapest, Hungary (3 May 1972).

The titanium ion-getter pumps in neutron generators are exposed to contamination from the tritium gas released from the targets. Examinations of an ion-getter pump removed from a neutron generator after two years of operation are reported. The pattern of tritium contamination in the different structural elements established by activity measurement and autoradiography are discussed and procedures for safe handling and regeneration of the contaminated pumps are suggested. (auth)

41523 HYDROGEN TARGETS IN THE PHYSICS OF HIGH-ENERGY PARTICLES. Golovanov, L. B. (Joint Inst. for Nuclear Research, Dubna, USSR). Probl. Fiz. Elem. Chastits At. Yadra; 2: No. 3, 717-62(1972). (In Russian).

Liquid hydrogen targets for experiments performed in high energy physics using electronic methods are considered. The material on targets is systematized. The methods of determination of main parameters and references for design calculations are given. The hydrogen targets developed in JINR for physical experiments in Dubna and Serpukhov are described. The precision arrangement with a liquid hydrogen target and jet target is described in detail. (57 references). (auth)

41524 SPATIAL DEPENDENCY OF BREMSSTRAHLUNG ENERGY CHARACTERISTICS FROM LINEAR ACCELERATOR. Miki, Ryota (Kinki Univ., Osaka); Kondo, Yoshihide; Azuma, Toshio. Kinki Daigaku Genshiryoku Kenkyusho Nenpo; 8: 1-5(1970). (In Japanese).

In a series of irradiation experiments with the 16 MeV electron linear accelerator at the Radiation Center of Osaka Prefecture, an aluminum disk, 10 mm in thickness, was attached to the water-cooled Au converter housing to absorb the scattered electrons. In this particular irradiation arrangement, spatial dependency of bremsstrahlung energy characteristics were observed from activation data of several elements which have different threshold energies for photonuclear reactions. This spatial dependency may introduce considerable effect on the yields of photonuclear reactions depending on the positions of irradiation samples relative to the beam center on the Au converter. Stacked monitor foils were used to check this effect. (auth) (Japan)

41525 NUCLEAR WELL LOGGING APPARATUS. Martin, P. W. Canadian Patent 893,929. 22 Feb 1972.

An apparatus for the generation of high energy neutrons to bombard a substance to be investigated, and a means for detecting and analyzing resulting radiations from the substance, is described. The invention may be used for radioactivity logging of oil well bores and other subsurface formations. An ion accelerator using a deuterium-tritium or a tritium-deuterium reaction is provided for generating high energy neutrons of the order of 14 MeV which can be pulsed. The accelerator is self-contained, with the ion source and ion acceleration taking place in the same compartment under the same pressure so that pumps will not be required and the size of the device will permit its use in a bore hole. (Canada)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

Refer also to abstract 41682.

Cosmic Radiation

Refer also to abstracts 41747, 41753–41760, 41771–41773, 41789–41797, 41832, 41846, 41883, 41912, and 41915.

41526 CHEMICAL COMPOSITION OF COSMIC RAYS. II. Aller, Lawrence H. (Univ. of California, Los Angeles). Sky Telesc.; 43: No. 6, 362-3(Jun 1972).

Solar cosmic radiation is discussed and the origin of primary cosmic radiation is considered. (W.D.M.)

41527 ISOTOPIC COMPOSITION AND ELEMENTAL ABUNDANCE OF GALLIUM IN METEORITES AND IN TERRESTRIAL SAMPLES. De Laeter, J. R. (Western Australian Inst. of Tech., South Bentley). Geochim. Cosmochim. Acta; 36: No. 7, 735-43(Jul 1972).

The isotopic composition of gallium in six iron meteorites and a terrestrial standard were measured using a solid-source mass spectrometer. Isotopic abundances of meteoritic and terrestrial gallium agree to within 0.11%. The concentration of gallium in 21 iron and 5 stone meteorites and in 13 standard rocks was determined using the method of isotope dilution. In general, the agreement between this work and other published data is excellent. (auth)

41528 SURVEY OF THE ISOTOPIC AND ELEMENTAL ABUNDANCE OF ZINC. Rosman, K. J. R. (Univ. of Western Australia, Perth). Geochim. Cosmochim. Acta; 36: No. 7, 801-19(Jul 1972).

A mass spectrometric technique applicable to the study of high ionization potential elements was used to investigate the possibility of natural processes producing variations in the isotopic composition of zinc. No significant variations were detected in the samples studied. The isotopic abundances of the mass 64, 66, 67, 68, and 70 isotopes in terrestrial zinc were estimated to be 48.6 ± 0.1, 27.90 ± 0.08, 4.10 ± 0.03, 18.8 ± 0.2, and 0.62 ± 0.01% respectively. Zinc concentrations were determined in 14 stone, 1 stony-iron, and 20 iron meteorites and in a large number of terrestrial samples using isotope dilution and atomic absorption methods. The range of concentrations found in stone meteorites and terrestrial rocks is similar to that previously reported, but for the iron meteorites a slightly wider concentration range was observed (0.026 to 90 ppm). (auth)

41529 GAS RETENTION CHRONOLOGY OF PETERSBURG AND OTHER METEORITES. Podosek, F. A. (California Inst. of Tech., Pasadena). Geochim. Cosmochim. Acta; 36: No. 7, 755-72(Jul 1972).

Argon and xenon data are presented for a thermal release study on a neutron-irradiated sample of the eucrite meteorite Petersburg. Xenon spallation corrections are made by the method of correlation systematics, and the relationship of lunar systematics to the systematics derived for the Angra dos Reis meteorite is discussed. Correlation systematics are also used in reevaluation of neutron-activation xenon data for other meteorites in which spallation effects are prominent. Petersburg has no excess ^{129}Xe attributable to in situ decay of ^{129}I, and a ^{244}Pu/^{238}U ratio corresponding to onset of xenon retention 146 ± 14 million years after the chondrite St. Severin. The argon data show substantial loss of radiogenic ^{40}Ar and do not define a ^{40}Ar–^{39}Ar plateau, establishing a lower limit K–Ar age of 4.35×10^9 yr, relative to an assumed age of 4.60×10^9 yr for St. Severin. Comparison with strontium data for other eucrites and the chondrite Guareña suggests an interval of 220 million years between fractionation from a rubidium-rich reservoir and the final cooling of Petersburg. The calcium-rich achondrite Lafayette has no detectable decay products of either ^{129}I or ^{244}Pu, indicating a gas-retention formation time at least 350 million years after St. Severin. The current best value of the ^{244}Pu/^{238}U ratio in the chondrite St. Severin at the time of its formation is 0.0154 ± 0.0014, 21% higher than previously reported. (auth)

41530 COSMOGENIC ^{26}Al AND ^{22}Na IN A LUNAR REGOLITH RECOVERED BY LUNA-16. Vinogradov, A. P.; Lavrukhina, A. K.; Gorin, V. D.; Ustinova, G. K. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 202: No. 2, 437-40(11 Jan 1972). (In Russian).

Samples of rock from four large areas on the visible side of the moon, upon analysis in laboratories on earth, proved to represent two types, at least: breccia and regolith. The depth distribution in these samples of ^{22}Na and ^{26}Al was determined, and a comparison was made and is discussed. Extrapolating to the moment of sampling by Luna-16 yielded the following values for average activity in disintegrations/min · kg of sample: for ^{26}Al, 61; for ^{22}Na, 47. (K.S.W.)

41531 ABSOLUTE VERTICAL COSMIC-RAY MUON INTENSITY AT SEA LEVEL. Ashton, F.; Tsuji, K.; Wolfendale, A. W. (Durham Univ., Eng.). Nuovo Cim.; 9B: No. 2, 344-50(11 Jun 1972).

The absolute vertical intensity of muons with momentum above 0.88 GeV/c at sea level was measured and found to be $(8.22 \pm 0.40) \cdot 10^{-3}$ cm^{-2} sr^{-1} s^{-1}. This value was close to what would be expected from recent determinations by Allkofer et al. and was significantly higher than the normalization value for a number of years. By using other absolute measurements in this region of momentum, the integral and differential muon intensities at the standard momentum of 1 GeV/c were found to be $(7.58 \pm 0.40) \cdot 10^{-3}$ cm^{-2} sr^{-1} s^{-1} and $(3.18 \pm 0.17) \cdot 10^{-3}$ cm^{-2} sr^{-1} s^{-1} (GeV/c)$^{-1}$, respectively. (auth)

41532 ELECTRON PARAMAGNETIC RESONANCE OF RADIATION DAMAGE IN A LUNAR ROCK. Tsay, F.; Chan, S. I.; Manatt, S. L. (California Inst. of Tech., Pasadena). Nature (London) Phys. Sci.; 237: No. 77, 121-2(19 Jun 1972).

Evidence is reported for radiation induced EPR signals in an Apollo lunar rock sample. The results indicate that radiation damage was less extensive than expected; this was in agreement with thermoluminescence measurements. The presence of both electron and hole traps was clearly shown; the EPR technique appears to be more effective than high-temperature thermoluminescence in detecting trapped electrons and holes with high activation energies. (UK)

41533 LOW FREQUENCY RADIO EMISSION FROM EXTENSIVE AIR SHOWERS. Allan, H. R. (Imperial Coll. of Science and Tech., London). Nature (London); 273: No. 5355, 384-5 (16 Jun 1972).

It is stated that the observed radio emission from extensive air showers at frequencies between 30 and 100 MHz is in good agreement with theory, but at lower frequencies the situation is much less satisfactory. Theory predicts that the field strength per unit bandwidth should rise smoothly from zero towards the observed values at 30 to 100 MHz, but the experimental values between 2 and 5 MHz are about 100 times larger. Calculations intended to set a generous upper limit to this field strength are presented, based on the least controversial elements of the theory. (UK)

41534 ACTIVATION ANALYSIS DETERMINATION OF 40 ELEMENTS IN LUNAR MATERIAL. Brunfelt, A. O. (Univ. of Oslo); Steinnes, E. Dan. Kemi; 53: No. 4, 49-52; 55(1972). (In Norwegian).

A neutron-activation scheme for analysis of lunar material is described. It is possible to determine up to 42 elements on the basis of about 400 mg of material. The method is also applicable to other types of geological material, e.g., meteorites or core samples from deep sea basins. The scheme was tested with the standard rock basalt BCR-1 from the US Geological Survey. (B.P.) (Denmark)

41535 DEPENDENCE OF THE COEFFICIENT OF INELASTICITY ON THE ENERGY OF THE NUCLEON. Akimov, V. V.; Grigorov, N. L.; Kozlov, V. D. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2040-3(Oct 1971). (In Russian).

The calculation of the nucleon flux at the atmospheric depth 1000 g · cm^{-2} in the hypothesis that the primary spectrum of protons, the spectrum of all particles, and the increase of the inelastic cross section of interaction with increase of energy from experimental data obtained by the satellite "Proton" does not agree with other experimental data. It is sufficient to assume a dependence of the coefficient of inelasticity on the energy of the nucleon. (tr-auth)

41536 GAMMA SPECTRA OBTAINED WITH A MULTILAYER X-RAY CAMERA AT A DEPTH OF 700 g.cm^{-2}. Amineva, T. P.; Varkovitskaya, A. Ya.; Dubrovina, S. A.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2049-53(Oct 1971). (In Russian).

A multilayer x-ray camera was used to obtain the spectrum of γ quanta by both the impulse and calorimetric methods simultaneously for comparison purposes. The camera contained alternate layers of x-ray film and lead sheet, and electrons and γ quanta in passing through this assembly left dark spots that could be scanned photometrically. A total of 431 quanta with energies greater than 5×10^{11} eV were analyzed, of which 26 were formed by decay of neutral pions generated in the target. Integral energy spectra of γ quanta in the atmosphere were recorded at a depth of 700 g $\cdot$ cm^{-2}. (K.S.W.)

41537 ENERGY SPECTRA OF MUONS IN THE VERTICAL FLUX OF COSMIC RADIATION. Erlykin, A. D.; Kulichenko, A. K.; Maznichenko, S. S.; Machavariani, S. K.; Meshkov, E. A. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2151-4(Oct 1971). (In Russian).

With the purpose of rendering more precise 1968 measurements of the energy spectra of cascades formed by high-energy muons, modifications were made in the camera. Integral spectra of cascades were determined at angles less than 50° to the zenith. (K.S.W.)

41538 U-Th-Pb SYSTEMATICS IN THREE APOLLO 14 BASALTS AND THE PROBLEM OF INITIAL Pb IN LUNAR ROCKS. Tera, Fouad; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett.; 14: No. 3, 281-304(Apr 1972).

The isotopic composition of Pb and the elemental concentration of U, Th, and Pb were measured on "total" rock samples 14053, 14073, and 14310 and on mineral separates of 14310 and 14053. (W.D.M.)

41539 LUNAR ZIRKELITE: A URANIUM-BEARING PHASE. Busche, F. D.; Prinz, Martin; Keil, Klaus; Kurat, Gero (Univ. of New Mexico, Albuquerque). Earth Planet. Sci. Lett.; 14: No. 3. 313-21(Apr 1972).

Zirkelite (simplified $CaZrTiO_5$) containing 7 to 17 wt % oxides of trivalent elements (largely yttrium and the rare earths) and minor amounts of U, Th, and Pb is described from an Apollo 12 feldspathic peridotite (12036,9) and two KREEP-type norite lithic fragments separated from Apollo 14 loose fines (14163,39 and 14257,3). Quantitative electron microprobe analyses indicate that this lunar phase conforms more closely to the zirkelite formula (generalized $A^{2+}B_2^{4+}O_5$) than to the zirconolite formula (generalized $A^{2+}B_3^{4+}O_7$). (auth)

41540 ALPHA SPECTROMETRY OF A SURFACE-EXPOSED LUNAR ROCK. Grjebine, T.; Lambert, G.; Le Roulley, J. C. (CNRS, Gif-sur-Yvette, France). Earth Planet. Sci. Lett.; 14: No. 3, 322-4(Apr 1972).

Surface alpha radioactivity of a Moon rock was measured in order to find the activity of ^{210}Po that could be designated as a descendant of radon outgassed from the lunar soil. No surface activity was found within statistical error limits. If such a process does exist and the deposit remains on the rock, it must be smaller than 2×10^{-5} dps/cm^2. It is proposed that the absence of this phenomenon may be attributed to vacuum and thermal conditions in the lunar soil. (auth)

41541 OLD AND RECENT IRRADIATIONS OF AUBRITES. Poupeau, G.; Berdot, J. L. (CNRS, Paris). Earth Planet. Sci. Lett.; 14: No. 3, 381-96(Apr 1972). (In French).

Three gas-rich aubrites (Bustee, Khor Temiki, and Staroe Pesyanoe) were studied and compared with five other non gas-rich aubrites (Aubres, Bishopville, Cumberland Falls, Norton County, and Shallowater), by means of the track method. The gas-rich objects showed a strong correlation between the percentage of solar-flare-irradiated crystals (track-rich crystals, C.R.T.) and the solar-wind trapped ^{36}Ar concentrations. A similar trend (though not identical) is observed between ^{36}Ar and C.R.T. in many lunar soils. Furthermore, by considering in each of the 8 aubrites the track production rate/my attributable to the "exposure age" of the meteoroids, the following objects (Staroe Pesyanoe, Khor Temiki, and Norton County) showed a track density gradient background clearly attributable to irradiation by galactic cosmic rays. The minimum track production rate in aubrites, excepting Shallowater, showed very low values (<0.0002 to 8.8×10^4 cm^{-2} my^{-1}) suggesting either high ablation/fragmentation during the atmospheric entry or an irradiation stage at great depth (>300 g cm^{-2}) in the parent body. The latter suggestion seems applicable to objects like Cumberland Falls aubritic portion and Norton County. Preirradiation stages on a parent body may account for both the surface exposure to the solar wind and solar-flare-irradiated crystals, along with the excess neutron flux as observed in Norton County, if the new "exposure age" value (~90 my) is considered. In such a case, a very efficient turnover had to be acting at the time the preirradiation occurred. Among aubrites, Shallowater appears to be a very peculiar object on petrographical, chemical, trapped noble gases, and exposure ages grounds. The Shallowater sample studied showed a very high track production rate: 26×10^4 cm^{-2} my^{-1} which can be well explained on account of the meteoroid exposure age, either on the basis of cosmogenic rare gas or cosmic-ray track data. (auth)

41542 EXTENSIVE-AIR-SHOWER STUDIES OF COSMIC GAMMA RAYS AND COSMIC-RAY COMPOSITION. Grindlay, Jonathan Ellis. Cambridge, Mass.; Harvard Univ. (1971). 148p. University Microfilms Order No. 72-15,057.

Thesis.

Calculations for the Compton-synchrotron spectrum of gamma rays produced in the Crab Nebula were performed, using the exact Compton scattering formalism, an assumed radial variation (1/r) of the nebular magnetic field due to the pulsar, and the measured radial variation of the optical intensity. A relatively higher yield of gamma rays near $\sim 10^{12}$ eV was found than in previous calculations assuming homogeneity. In an effort to detect such gamma rays by the detection of the extensive air showers (EAS) they would contribute to the background of cosmic-ray-initiated showers, previous EAS studies were reviewed to determine the possibility of identification of the primary particle initiating an individual EAS. The muon component and longitudinal development were found to be most important. Numerous experimental observations of EAS were then conducted to ascertain whether these effects could be observable in the detailed structure of the Cherenkov light produced in EAS. Strong evidence is presented for the existence of a unique component of the Cherenkov radiation from the penetrating shower cores, tentatively identified as the muon component. A three-dimensional Monte Carlo calculation of EAS initiated by protons confirmed this hypothesis. The experimental methods for identifying the core Cherenkov emission were then applied to observations of EAS from the direction of the Crab nebula. Those EAS not detected at the penetrating core were regarded, in accordance with the calculations, as candidate gamma-ray events. A $\lesssim 2\sigma$ increase in these events was observed within 2 minutes of the transit of the Crab nebula through the detector array field of view. From this a new upper limit is estimated for the detection ($>3\sigma$) of continuous gamma rays with $E_\gamma > 6 \times 10^{11}$ eV to be $F(>E_\gamma) < 3.5 \times 10^{-11}$ photons/cm^2-sec, and a limiting nebular magnetic field is also given. From all the data recorded with timing information a possible detection is reported at the $\gtrsim 4\sigma$ level of pulsed gamma rays with $E_\gamma > 6 \times 10^{11}$ eV in the interpulse of NP-0532. The flux would be $F(>E_\gamma) \sim 1.65 \times 10^{-11}$ photons/cm^2-sec and appears consistent with an extrapolation of the x-ray pulse spectrum though it contradicts previous upper limits at $E_\gamma > 2 \times 10^{11}$ eV. Finally, the EAS identification methods were applied to a study of the relative strength of the cores in some 300 EAS. From calculations of EAS initiated by He and C nuclei as well as protons, the cosmic-ray composition at 3×10^{12} eV is inferred to be in approximate agreement with direct measurements at $\lesssim 10^{11}$ eV, except for a suggestion of an overabundance of superheavy cosmic rays. (Diss. Abstr. Int., B)

41543 VARIATION WITH ZENITH ANGLE OF THE INTEGRAL INTENSITY OF MUONS NEAR SEA LEVEL. Flint, R. W.; Hicks, R. B.; Standil, S. (Univ. of Manitoba, Winnipeg). Can. J. Phys.; 50: No. 8, 843-8(15 Apr 1972).

The integral intensity of the cosmic-ray muon flux (>0.28 GeV/c) near sea level was measured in the zenith angle range 75 to 90°. Very few other experimental measurements have been made in this range. The present results agree closely with the predictions of a current theoretical model except at very large zenith angles, where the measured intensities are somewhat higher than predicted. (auth) (Canada)

41544 GRAVITATIONAL N-BODY PROBLEM. Proceedings of IAU Colloquium No. 10 Held in Cambridge, England, August 12-15, 1970. Lecar, Myron (ed.). Astrophysics and Space Science Library. Volume 31. Dordrecht, Netherlands; D. Reidel Publishing Company (1972). 451p. f 115.-. (CONF-700857).

From the viewpoint of stellar dynamics, stellar systems fall into two classes, depending on whether or not encounters (the analog to collisions in gas kinetic theory) contribute to their dynamical evolution. Stellar associations, galactic clusters, globular clusters, and clusters of galaxies belong to the collisional systems. These were the first systems to be computer simulated. Recently developed is the simulation of galaxies, whose dynamics are dominated by collective (collisionless) effects. A successful gravitational theory of the Spiral Arms has been produced. In Part I, collisional systems are discussed by analytic treatments and numerical experiments, and in Part II, collisionless systems are discussed by analytic treatments and numerical experiments. In Part III, numerical experiments and analytical treatments in plasma physics are discussed. Part IV encompasses a summary and in Part V, six methods of computer simulation of the gravitational N-body problem are given. (J.C.W.)

Stars

Refer also to abstracts 41698 and 42040.

41545 CONCERNING THE URCA PROCESS AT HIGH TEMPERATURES AND DENSITIES. McFee, Ronald William. Lincoln, Neb.; Univ. of Nebraska (1971). 86p. University Microfilms Order No. 72-16,002.

Thesis.

Model URCA and photo-beta neutrino fluxes from hot matter where positron capture by nucleons is significant were investigated for the range of temperatures 5×10^8 to 5×10^{10} K. The new results indicated that URCA rates are much more important than previous estimates, which neglected positron capture by unstable nuclei, have indicated. Depending on the mass difference between isotopes and the temperature, the new results may be as much as 10 to 10^6 times as great for temperatures between 5×10^9 K and 5×10^{10} K. Simple model rates which do not include the effects of nuclear structure were calculated for a variety of odd mass number nuclei, and a model for calculating rates from even mass nuclei was developed and applied to isobar 56. The new results indicated that the loss rates for this process from even mass number nuclei are comparable to the rates from odd mass number nuclei at temperatures above about 10^9 K. These new rates were compared with the total Feynman neutrino luminosities, which include the pair neutrino, plasmon neutrino, and photo-neutrino processes. For most nuclear compositions there is a wide range of densities and temperatures for which the URCA luminosity will dominate the total pair neutrino, plasmon, and photo-neutrino processes. The effect of the lower lying nuclear levels (photo-beta process) on the URCA rates was assessed for the isotope triplet ^{56}Mn–^{56}Fe–^{56}Co. The levels cause a slight broadening of the structure and an effective lowering of the mass difference between isotopes. The modification of the URCA luminosity due to the presence of large magnetic fields (on the order of $H_c = m^2c^3/e\hbar =$ 4.4.4 $\times 10^{13}$ gauss) was considered. The new results indicated that while large magnetic fields have a subtle effect on the luminosity, the presence of the positrons reduces this effect at high temperatures. Some physical applications of these results are discussed. These include the cooling of hot stars and possible astrophysical determination of the self current coupling constant of the electron. The larger URCA rates will shorten the lifetimes of hot stars, and the fact that they are comparable to the Feynman rates makes the astrophysical determination of the self coupling constant of the electron more difficult than previously supposed. (Diss. Abstr. Int., B)

41546 GENERAL FORMULATION OF THE TRANSFER EQUATION. II. LINE FORMATION WITH GENERAL REDISTRIBUTION. Cannon, C. J. (Univ. of Sydney). Aust. J. Phys.; 25: No. 2, 177-95(Apr 1972).

The multidimensional equation of transfer for spectral line radiation under a general redistribution law is studied. It is shown that the equation may be rewritten as a system of equations of the "Feautrier" form, which are known to be exceedingly stable and efficient under numerical reduction. It is also shown that the inclusion of a multidimensional differential macroscopic velocity field does not alter the functional form of the equations obtained and therefore may also be treated by the general Feautrier technique. (auth)

41547 INVESTIGATION OF LONG PERIOD CEPHEIDS BELONGING TO THE SPHERICAL COMPONENT OF THE GALAXY. III. Vasil'yanovskaya, O. P.; Erleksova, G. E. Byull. Inst. Astrofiz., Akad. Nauk Tadzh. SSR; No. 57, 18-30(1970). (In Russian).

Asymmetry of the light curve–period, light amplitude–period, color–period, shape of the light curve–period, period change–light amplitude relations, and the position of Cepheids in the H–R diagram were considered. The division of long-period Cepheids belonging to the spherical component of the Galaxy into two groups was confirmed. The characteristic peculiarity of sudden period changes for these groups was found. The current period exists longer than the middle period. (auth)

41548 INVESTIGATION OF PERIODS FOR 12 CEPHEIDS. Nikulina, T. G. Byull. Inst. Astrofiz., Akad. Nauk Tadzh. SSR; No. 57, 31-5(1970). (In Russian).

The graphics O–C for six Cepheids are presented. Current elements of these Cepheids are determined. For six cepheids the periods are constant. (auth)

41549 CARBON IGNITION IN DEGENERATE STELLAR CORES. Paczynski, B. (Inst. of Astronomy, Warsaw). Astrophys. Lett.; 11: No. 2, 53-5(Jun 1972).

URCA processes within highly degenerate convective carbon-burning cores prevent carbon detonation in stars with masses below 8 $M_\odot$. Two types of supernovae and two kinds of pulsars are likely to be produced as a result of collapse following carbon exhaustion. (auth)

41550 TRANSITION PROBABILITIES FOR THE VIBRATION-ROTATION BANDS OF SILICON MONOXIDE. Hedelund, J.; Lambert, D. L. (Univ. of Texas, Austin). Astrophys. Lett.; 11: No. 2, 71-5(Jun 1972).

Transition probabilities for the vibration–rotation bands of SiO were derived from published laboratory measurements of the electric dipole moment. Identifications of the SiO bands in stellar spectra are briefly discussed. (auth)

41551 X-RAY EMISSION FROM FLARE STARS. Kahler, S.; Shulman, S. (Naval Research Lab., Washington, D. C.). Nature (London) Phys. Sci.; 237: No. 76, 101-2(12 Jun 1972).

It is stated that there is at present considerable interest in x-ray emission from flare stars and it has been claimed that under good conditions a detectable x-ray flux due to flares to UV Ceti would be seen at the Earth. Using the model due to Grindlay (Astrophys. J., 162: 187(1970)) it has been calculated that the total hard x-ray emission (E > 10 keV) from the galactic disk is two orders of magnitude greater than the upper limit set from satellite (OSO III) observations. In the present communication several difficulties with earlier approaches are discussed and it is shown that an empirical approach based on the strong similarities between solar and stellar flares can be used to calculate stellar x-ray fluxes; an upper limit is thus obtained on the unresolved flare star contribution to the diffuse hard x-ray emission from the galactic disk. (UK)

41552 STUDIES OF HYDRODYNAMIC EVENTS IN STELLAR EVOLUTION. I. METHOD OF COMPUTATION. Kutter, G. S. (Univ. of Virginia, Charlottesville); Sparks, Warren M. Astrophys. J.; 175: No. 2, 407-15(15 Jul 1972).

A numerical method of computation for hydrodynamic events in stellar evolution is described. The differential equations (spherical symmetry) of conservation of mass, momentum, and energy; energy transport by diffusion and convection; and the definition of velocity are replaced by finite-difference equations. By specifying a parameter θ between 0 and 1, the time differences are expressed as a mixture of backward ($\theta = 1$) and forward ($\theta = 0$) differences relative to the time at which the mass differences are computed. The solution proceeds by Henyey's iterative method. The useful range of θ lies between 0.5 and 1.0: For $0.5 < \theta \leq 1.0$, deviations from equilibrium are artificially dampened; at $\theta = 0.5$, neither damping nor amplification occurs. No numerical restrictions are placed on the time step. Thus, one can either follow a star's evolution by using $\theta = 1$ and long time steps or investigate the details of hydrodynamic events by using $\theta = 0.5$ and short time steps. Several test applications are described: Numerical stability, propagation of a shock wave, free-fall collapse, and nova outburst. The results are in satisfactory agreement with either analytical solutions or with numerical solutions obtained with an independent computer code. (auth)

41553 ANALYTIC APPROXIMATIONS TO THE MASS–RADIUS RELATION AND ENERGY OF ZERO-TEMPERATURE STARS. Nauenberg, Michael (Univ. of California, Santa Cruz). Astrophys. J.; 175: No. 2, 417-30(15 Jul 1972).

The variational principle is applied to two approximate forms of the energy integral of a star at zero temperature in order to obtain analytic expressions for the mass–radius relation and for the energy. Several well-known equations of state are considered, and the effects of rotation and of stored magnetic fields are included. Comparison of the analytic approximations with published numerical solutions of the exact equations show good agreement. (auth)

41554 PERTURBATIONS IN THE α-SYSTEM OF THE TiO MOLECULE. Phillips, John G.; Davis, Sumner P. (Univ. of California, Berkeley). Astrophys. J.; 175: No. 2, 583-8(15 Jul 1972).

A breaking-off of branches in bands of the α-System of TiO ($C\,^3\Delta - X\,^3\Delta$) has been ascribed to a series of perturbations experienced by excited vibrational states in the upper ($C\,^3\Delta$) electronic state, with v' ranging from 4 to 7. Approximate vibrational and rotational constants can be derived for the perturbing electronic state. The excitation energies of the perturbing state do not match with those of any known triplet or singlet electronic state of TiO, nor can convincing extrapolations be made from lower-lying states. (auth)

41555 FUNDAMENTAL DATA FOR MASSIVE STARS COMPARED WITH THEORETICAL MODELS. Stothers, Richard (Goddard Space Flight Center, New York). Astrophys. J.; 175: No. 2, 431-52(15 Jul 1972).

A new grid of nonrotating stellar models for the upper main sequence was calculated for a variety of initial chemical compositions and assumed modes of evolution. Theoretical isochrones in the H–R diagram were then constructed (with the help of published models for the post–main-sequence phases). A comparison of the theoretical data with observational data for massive members of eclipsing binary systems, clusters, and subgroups of associations in the (mass, spectral type)- and (mass, luminosity)-planes suggested that (1) currently adopted initial chemical compositions are probably correct ($X_e \sim 0.70$, $Z_e \sim 0.03$), although larger variations, particularly in Z_e, possibly occur; (2) chemical evolution, even in fast rotators, proceeds inhomogeneously; (3) the rotation of normal upper-main-sequence stars is approximately uniform; (4) mass exchange in a close binary system may lead to nonuniform rotation in the new primary component; and (5) mass loss seems to be rather small for normal massive stars including supergiants. Two independent ages for each cluster or association containing supergiants were derived, by using (1) the spectral type of the main-sequence turnup in the H–R diagram and (2) the average luminosity of the evolved supergiants; the two ages generally agreed well with each other, although they differed slightly for several stellar groups, probably as a result of a somewhat larger metals abundance than normal or a fast uniform rotation of the upper-main-sequence stars. The few available kinematic ages were usually much shorter than the nuclear ages. (auth)

41556 HELIUM-WEAK STARS. Molnar, Michael R. (Univ. of Wisconsin, Madison). Astrophys. J.; 175: No. 2, 453-64 (15 Jul 1972).

In an extensive investigation of spectral classification, the class of helium-weak stars is described. Their spectra are found to resemble the Bp-type stars with the distinction that the helium-weak group does not have the profuse and strongly enhanced metal lines characteristic of the Bp stars. In a quantitative analysis using model atmospheres, several helium-weak stars are found to have apparent helium deficiencies ($N_{He}/N_H \approx 0.02$). On the other hand, HD 37129, HD 36629, and HD 37807, previously classified as "helium-weak," appear to be normal early B-type stars—a conclusion which was also found by Norris. (auth)

41557 UNIQUE MAGNETIC AND SPECTRUM VARIATIONS OF HD 24712. Preston, George W. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 175: No. 2, 465-72(15 Jul 1972).

A series of coudé spectrograms is used to show that the effective magnetic field of HD 24712 varies in a period of 12.45 days with no polarity reversal. Strong antiphase variations between the lines of Mg and Eu also occur in this period. Maximum Eu line strength occurs at the phase of maximum effective field. Elements of intermediate atomic number Z show smaller spectral variations and the algebraic range of these variations increases systematically with Z. Finally, it is shown that marked spectrum variations in the absence of a magnetic polarity reversal do not pose a difficulty for the oblique-rotator model. (auth)

41558 REMARKS ON THE PROPOSED IDENTIFICATION OF PROMETHIUM IN HR 465. Wolff, Sidney C.; Morrison, Nancy D. (Univ. of Hawaii, Honolulu). Astrophys. J.; 175: No. 2, 473-5(15 Jul 1972).

Spectrograms of HR 465 obtained in 1966–1967 show that Pm II was not present at that time. A rediscussion of the observations made in 1960–1961 indicates that there is doubt that Pm was ever present. (auth)

41559 COMMENTS ON THE IDENTIFICATION OF PROMETHIUM IN HR 465. Cowley, Charles R.; Aller, Margo F. (Univ. of Michigan, Ann Arbor). Astrophys. J.; 175: No. 2, 477-80(15 Jul 1972).

The general principles of line identification are discussed in connection with the identification of promethium in HR 465. It is shown that the Russell–Bowen formalism for the significance of wavelength coincidences is improper for most wavelength lists. An alternative procedure, due to Upton, is applied to HR 465, resulting in a 2 σ significance level for the wavelength coincidences alone. Coincidences in the character of the laboratory and stellar lines increase this significance to perhaps 2.8 σ (one chance in 200 of fortuitous occurrence). This paper and its predecessor disagree primarily in optimism versus pessimism on a question which both agree cannot be conclusively resolved. (auth)

41560 RECALIBRATION OF THE ABSOLUTE MAGNITUDES OF SUPERGIANTS. Stothers, Richard (Goddard Space Flight Center, Greenbelt, Md.). Publ. Astron. Soc. Pac.; 84: No. 499, 373-8(Jun 1972).

Because of the usefulness of supergiants in studies of galactic structure, an improved calibration of the visual absolute magnitudes for luminosity class I stars is derived. Significant differences from the results of Blaauw and Schmidt–Kaler are found at some MK classes. (auth)

41561 SPECTROSCOPIC STUDY OF AG VIRGINIS. Hill, Graham; Barnes, Jeannette V. Publ. Astron. Soc. Pac.; 84: No. 499, 382-7(Jun 1972).

Radial velocities determined at the Kitt Peak National Observatory were analyzed to yield revised orbital elements for the eclipsing binary AG Virginis. These orbital elements were: $P = 0.6426514$ days, $T = JD_\odot\ 2440660.70$, $\omega = 62°$, $e = 0.14$, $V_0 = -5.6$ km sec^{-1}, and $K = 70.9$ km sec^{-1}. The possible evolutionary state of the system is also discussed. (auth)

41562 DISCOVERIES ON SOUTHERN OBJECTIVE-PRISM PLATES. III. THREE NEW HYDROGEN-DEFICIENT STARS AND A BRIGHT B-TYPE SUBDWARF. MacConnell, D. J. (Univ. of Michigan, Ann Arbor); Frye, R. L.; Bidelman, W. P. Publ. Astron. Soc. Pac.; 84: No. 499, 388-91(Jun 1972).

Four relatively bright peculiar stars are presented; three show no hydrogen lines, and the fourth is a subdwarf B star. UBV photometry is given for three of the stars. (auth)

41563 UBV OBSERVATIONS OF THE ECLIPSING BINARY LY AURIGAE. Landolt, Arlo U.; Blondeau, Karen L. (Louisiana State Univ., Baton Rouge). Publ. Astron. Soc. Pac.; 84: No. 499, 394-9(Jun 1972).

Photoelectric observations, made in conjunction with the international campaign, are presented for the eclipsing binary LY Aurigae. (auth)

41564 RED GIANTS IN THE HYADES GROUP. Eggen, O. J. (Australian National Univ., Canberra). Publ. Astron. Soc. Pac.; 84: No. 499, 406-19(Jun 1972).

An examination of the space motion of 2860 red giants in the Catalogue of Bright Stars for which apparent motions are available yielded only 114 stars that on the basis of their loci in the (U,V) plane, alone, could be members of the Hyades group. Ten of these candidates are possible members only, either because of observational difficulties or because of the lack of sufficient dependence of the V-velocity on the proper motion to derive a group parallax. The remaining stars are divided into probable members (86 stars), for which the available (R,I) photometry shows a well-defined (M_{Bol}, R–I) relation derived from the group parallaxes, and nonmembers (18 stars) which show large deviations from this relation. The group members include a wide selection of red giants from those of early G-type to large amplitude, M-type variables, and the S-type star π^1 Gruis. However, the luminosity function, derived from the fact that the sample is complete to visual magnitude 6.5, shows that these variables are very rare and knowledge of their evolutionary characteristics will largely depend upon those in stellar groups. (auth)

41565 SEARCH FOR SHORT-PERIOD LIGHT VARIABILITY AMONG STARS IN h AND χ PERSEI. Percy, John R. (Univ. of Toronto). Publ. Astron. Soc. Pac.; 84: No. 499, 420-3(Jun 1972).

Thirty-nine stars in the nuclei of the galactic clusters h and χ Per were tested for short-period light variability. Two stars showed evidence of short-period ($\leqq$10 hours) light variability; these stars both have spectral types and absolute magnitudes similar to those of known β Cephei stars. Five stars showed evidence of longer-period light variability. (auth)

41566 MINIMUM-LIGHT SPECTRA OF NINE M-TYPE VARIABLE STARS. Wyckoff, S.; Wehinger, P. (Univ. of Kansas, Lawrence). Publ. Astron. Soc. Pac.; 84: No. 499, 424-6 (Jun 1972).

Spectral types are given for eight M-type long-period variables and one SRa variable all of which were observed at or near minimum light. Several explanations of the apparently anomalous spectral type (M8) found for R Vir are discussed. (auth)

41567 1971 ECLIPSE OF 32 CYGNI: UBV AND SPECTROPHOTOMETRIC OBSERVATIONS. Griffiths, Donald W.; Stencel, Robert E. (Univ. of Wisconsin, Madison). Publ. Astron. Soc. Pac.; 84: No. 499, 427-9(Jun 1972).

Standard UBV and 20 Å spectrophotometry at four blue wavelengths obtained during the November 1971 eclipse of 32 Cyg is reported. (auth)

41568 SPECTROSCOPIC STUDY OF AT PEGASI. Hill, Graham; Barnes, Jeannette V. Publ. Astron. Soc. Pac.; 84: No. 499, 430-3(Jun 1972).

Radial velocities determined at the Kitt Peak National Observatory and the Cerro Tololo Inter-American Observatory were analyzed to yield new orbital elements for the eclipsing binary AT Peg. These orbital elements are: $P = 1.146080^d$, T (max. pos. vel.) = $JD_\odot$ 2440819.735, $e = 0.02$, $\omega = 300°$, $K = 88$ km sec^{-1} and $V_0 = 4$ km sec^{-1}. A revised photometric ephemeris, based on published data, was also computed. (auth)

41569 IS HR 5491 REALLY A PULSATING Am STAR? Breger, Michel (State Univ. of New York, Stony Brook); Maitzen, Hans M.; Cowley, Anne P. Publ. Astron. Soc. Pac.; 84: No. 499, 443-5(Jun 1972).

The Am star at the south pole, HR 5491, reported by Bessell and Eggen (1972) to be pulsating was reinvestigated. The metallic-line nature was confirmed, but careful photometric observations on November 10, 1971 showed no evidence of light variability. Other variables with a high photometric metallicity index in the Hyades group are shown to be above the main sequence, so that so far little evidence for pulsation of classical Am stars exists. (auth)

41570 FOURTEEN NEW PECULIAR STARS. Bond, Howard E. (Louisiana State Univ., Baton Rouge). Publ. Astron. Soc. Pac.; 84: No. 499, 446-7(Jun 1972).

A list of stars with peculiar spectra noted on objective-prism plates is given. The list includes seven peculiar A-type stars, six metallic-line stars, and a peculiar B-type star. (auth)

41571 TIME OF MINIMUM FOR AH VIRGINIS. Landolt, Arlo U. (Louisiana State Univ., Baton Rouge). Publ. Astron. Soc. Pac.; 84: No. 499, 448-9(Jun 1972).

A time of minimum light at secondary eclipse is given for the eclipsing binary AH Virginis. (auth)

41572 WOLF-RAYET STARS HD 90657 AND HD 117688. Niemela, Virpi S. (Instituto de Astronomia y Fisica del Espacio, Buenos Aires). Publ. Astron. Soc. Pac.; 84: No. 499, 450-3(Jun 1972).

Recent spectrographic observations of HD 90657 and HD 117688 do not confirm their earlier classification as W–R objects that are intermediate to those that belong to the WN and WC sequences. HD 90657 is very probably a spectroscopic binary with a period of a few days. (auth)

41573 EFFECT OF SYSTEMATIC gf-VALUE ERRORS ON STELLAR CURVES OF GROWTH. Evans, J. C. (Kansas State Univ., Manhattan); Schroeder, Leon W. Publ. Astron. Soc. Pac.; 84: No. 499, 454-8(Jun 1972).

From an analysis of 101 Fe I lines in the spectrum of the star θ UMa, a value was derived for the magnitude of the systematic increase, noted by several laboratory studies, in the Corliss and Tech (1968) gf-values with increasing energy of the upper level. This result was in reasonable agreement with the findings of the laboratory measurements and showed that the best estimate of the linear increase was 0.2 dex eV^{-1} for lines with upper excitation potentials above 2.5 eV. The effect of this systematic error on the curve of growth is to spread the observational data along the direction of the abscissa. Such a dispersing of the data could be misinterpreted possibly as due to a large microturbulence velocity and thus lead to an abundance which is correspondingly too small. (auth)

41574 RADIAL VELOCITIES OF SOME STARS IN NGC 1893. Jones, F. Shirley (Trinity Coll., Hartford). Publ. Astron. Soc. Pac.; 84: No. 499, 459-60(Jun 1972).

Radial velocity measures of eight stars in the field of NGC 1893 are reported. (auth)

41575 N III $\lambda\lambda$4640, 4097 LINES IN Of STARS. Mihalas, Dimitri (Univ. of Colorado, Boulder); Hummer, D. G.; Conti, Peter S. Astrophys. J.; 175: No. 2, L99-104(15 Jul 1972).

Detailed calculations based on non-LTE plane-parallel model atmospheres show that the N III emission lines at $\lambda\lambda$4634, 4640, 4641 observed in Of stars are produced primarily by dielectronic recombination to 3d ^3D followed by the 3d–3p transition in a compact atmosphere. The 3p state in turn is drained by two-electron transitions to the $2p^2$ levels. It is found that λ4640 is in emission for $T_{eff} \leq 37{,}000°K$ for main-sequence objects (33,000°K for giants), while λ4097 remains strongly in absorption, in accordance with observations. The calculated equivalent widths are in substantial agreement with the observed values for those Of stars with He II λ4686 in absorption, i.e., for those objects designated by Walborn as O((f)). (auth)

41576 IDENTIFICATION OF THE 100-MICRON SOURCE NO. 15. Johnson, Hugh M. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Astrophys. J.; 175: No. 2, L105-6(15 Jul 1972).

The source coincides with the planetary nebula He 2-53 (285 + 1°2). The 100-μ flux density exceeds the optically predicted bremsstrahlung flux density by a factor of 10^6. However, it is shown that this is not seriously out of the range of results for the identified sources of radiofrequency continuum in the 100-μ catalog. (auth)

41577 VY CANIS MAJORIS AS A MULTIPLE STAR. Worley, Charles E. Astrophys. J.; 175: No. 2, L93-4(15 Jul 1972).

The nature of VY Canis Majoris as a multiple star is discussed, and new observations are reported. (auth)

41578 ULTRASHORT-PERIOD BINARIES. II. HZ 29 (= AM CVn): A DOUBLE-WHITE-DWARF SEMIDETACHED POSTCATACLYSMIC NOVA. Faulkner, John (Univ. of California, Santa Cruz); Flannery, Brian P.; Warner, Brian. Astrophys. J.; 175: No. 2, L79-83(15 Jul 1972).

The peculiar white dwarf HZ 29 is in fact an eclipsing binary system with $P \sim 1051.05$ s. A hydrogen-containing secondary is most unlikely. A satisfactory model has a degenerate helium secondary of mass $\sim 0.041\ M_\odot$. It is suggested that this is the remnant core of a nova secondary which has suffered complete envelope mass loss as a result of gravitational radiation angular momentum losses. The separation of components is $\sim 10^{10}$ cm, primary orbital velocities appear to be marginally detectable, and the period should be increasing by 1 or 2 parts in 10^8 per annum. (auth)

41579 NEW MEASUREMENTS OF CIRCULAR POLARIZATION AND AN EPHEMERIS FOR THE VARIABLE WHITE DWARF G195-19. Angel, J. R. P. (Columbia Univ., New York); Illing, R. M. E.; Landstreet, J. D. Astrophys. J.; 175: No. 2, L85-7(15 Jul 1972).

Observations of the white dwarf G195–19 made for over a year show that the periodic variation in circular polarization continues with constant frequency and amplitude; an accurate value for the period, 1.3309 ± 0.0004 days, is obtained. While the variation in blue-green light is sinusoidal, extensive measurements in red light show an asymmetric curve, reaching a minimum about 6 hours earlier than in the blue–green. (auth)

41580 LUMINOSITY FUNCTION FOR GLOBULAR CLUSTERS. I. OBSERVATIONS ON M5 AND M13. Shimoda, Mahiro; Tanikawa, Kiyotaka (Tokyo Univ.). Publ. Astron. Soc. Jap.; 24: No. 1, 1-12(Jan 1972).

Luminosity functions for M5 and M13 were obtained down to the visual magnitude 21 and 19, respectively, using plates from the Kitt Peak 84-inch and Palomar 200-inch reflectors. The results are in essential agreement with the result for M13 by Shimoda and Kimura (1968), obtained using smaller scale plates from the Okayama 74-inch reflector. Down to the turnoff point from the main sequence, degrees of the central concentration at different magnitude levels appear to be constant for both clusters, in agreement with the evolution theory. Counts in M5 at fainter magnitude levels apparently show a decrease in central concentration. For both clusters, a peak exists on the giant-branch luminosity function at or slightly above the horizontal-branch level. For M13, continuous (almost uniform) extension of the blue horizontal branch down to $V \sim 19$ mag is found. M5 has no blue branch stars down to the plate limit ($V \sim 22$ mag), beyond the cutoff of the blue horizontal branch at $V \sim 16.5$ mag found by Arp (1962). (auth) (Japan)

41581 LUMINOSITY FUNCTION FOR GLOBULAR CLUSTERS. 2. EVOLUTIONARY INTERPRETATION FOR M5, M13, AND M92. Shimoda, Mahiro (Tokyo Univ.). Publ. Astron. Soc. Jap.; 24: No. 1, 13-25(Jan 1972).

The luminosity functions for M5 and M13 obtained in the previous report (Shimoda and Tanikawa 1972) and for M92 by Hartwick (1970) are compared with the results of evolution theory. Comparison in the subgiant function indicates that the observation for the three clusters is consistent with theory for high helium abundance, in agreement with the result by Shimoda and Kimura (1968) and by Hartwick (1970). Comparison in the main-sequence function then suggests initial luminosity functions (differential escape of stars from the cluster, if it occurs, is superposed) for M5 and M92 to be decreasing functions of magnitude, if energy equipartition exists in the cluster. Overall lifetimes for the giant branch of the three clusters are found to be consistent with the theory, regardless of composition and age. More detailed comparison suggests that a peak on the giant branch discovered in the previous report for M5 and M13 corresponds to a hump predicted by evolution theory. The M92 function also has a similar peak. Peak-subtracted luminosity functions for the giant branch suggest a high helium abundance for M13 and M92 and a low helium abundance or the occurrence of nonsmooth evolution (other than the above mentioned hump) for M5. Comparison of the horizontal branch lifetimes with theoretical results for core helium–shell hydrogen burning model by Iben and

Rood (1970) indicates a high helium abundance for three clusters. Asymptotic branch lifetimes for three clusters are considerably smaller than those given by Iben and Rood (1970) for double shell source models. (auth) (Japan)

41582 GRAVITATIONAL COLLAPSE IN BRANS–DICKE THEORY OF GRAVITY. Matsuda, Takuya (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 2, 738-40(Feb 1972).

Predictions of the Einstein and Brans–Dicke theories are considered, and the conjectures that the predictions will be the same or different are discussed. The discrepancy between the two conjectures is clarified and an example is shown, in which Thorne and Dykla's (OAP-237 preprint) discussion is not correct, by analyzing the Brans Type I solution. (W.D.M.)

41583 THEORY OF SUPERDENSE STARS. Kodama, Takeshi; Yamada, Masami (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 47: No. 2, 444-59(Feb 1972).

A theory of cold static superdense stars composed of two or more components is presented. In this theory the number of each independent component is treated as a conserved number in contrast to the usual theories of neutron stars in which only the total baryon number is treated so. With the help of the variational principle and the equations of general relativity, simultaneous equations for stellar structure are derived. These equations are solved numerically for a stellar model in which protons and neutrons are treated as independent components by neglecting the β decay. (auth)

41584 NONSPHERICAL PERTURBATIONS OF RELATIVISTIC GRAVITATIONAL COLLAPSE. I. SCALAR AND GRAVITATIONAL PERTURBATIONS. Price, Richard H. (California Inst. of Tech., Pasadena). Phys. Rev., D; 5: No. 10, 2419-38 (15 May 1972).

When a nearly spherical star gravitationally collapses through its event horizon, it cannot leave behind a static gravitational field with nonspherical perturbations. The dynamics of these perturbations during collapse is studied with a scalar-field analog. Computations in comoving coordinates show that the field neither vanishes nor becomes singular as the star falls inside its gravitational radius. The scalar field on the surface of the star must vary as $a_1 + a_2 \exp(-t/2M)$ due to time dilation. An analysis is presented of the evolution of the exterior scalar field, based on a simple wave equation containing a space–time–curvature-induced potential barrier. This barrier is shown to be impenetrable to zero-frequency waves and thus a_1, the final value of the field on the surface of the star, is not manifested in the exterior; the exterior field vanishes. The detailed nature of the falloff of the field depends on backscattering off the potential. It is shown that an initially static l pole dies out as $t^{-(2l+2)}$. If there is no initial l pole but one develops during the collapse it must fall off as $t^{-(2l+3)}$. Wave equations with curvature-induced potential barriers have been derived by Regge and Wheeler and by Zerilli for gravitational perturbations. With these equations the analysis of gravitational perturbations is precisely the same as for the scalar ones. In particular, gravitational multipole perturbations (with $l \geq 2$) fall off at large t as $t^{-(2l+2)}$ or $t^{-(2l+3)}$, depending on initial conditions. (auth)

41585 NONSPHERICAL PERTURBATIONS OF RELATIVISTIC GRAVITATIONAL COLLAPSE. II. INTEGER-SPIN, ZERO-REST-MASS FIELDS. Price, Richard H. (California Inst. of Tech., Pasadena). Phys. Rev., D; 5: No. 10, 2439-54(15 May 1972).

A nearly spherical star collapses through its gravitational radius. Nonspherical perturbations exist in its density, pressure, electromagnetic field, and gravitational field, and in other (hypothetical) zero-rest-mass, integer-spin fields coupled to sources in the stars. Paper I analyzed the evolution of scalar-field and gravitational-field perturbations. This paper treats fields of arbitrary integer spin and zero rest mass, using the Newman–Penrose tetrad formalism. The analysis of each multipole (order = l) of each field (spin = s) is reduced to the study of a two-dimensional wave equation, with a "curvature potential" that differs little from one field to another. The analysis of this wave equation for the scalar case (s = 0) carries over completely to fields of arbitrary spin s. In particular, any radiatable multipole ($l \geq s$) gets radiated away completely in the late stages of collapse; if the multipole is static prior to the onset of collapse, it will die out as $t^{-(2l+2)}$ at late times. Nonradiatable multipoles ($l < s$) are conserved. This paper also treats gravitational perturbations in the Newman–Penrose framework, and supplies some technical details missing in the gravitational-perturbation analysis of Paper I. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

41586 (N–72–14810) ULTRAVIOLET INVESTIGATIONS OF COSMIC X-RAY SOURCES AND ANALOGOUS OBJECTS. Final Report. Johnson, Hugh M. (Lockheed Missiles and Space Co., Palo Alto, Calif.). 31 Dec 1971. Contract NASw-1977. 4p. (NASA-CR-125096). NTIS.

Data on the uv spectrum of the Crab Nebula and on uv and radio-frequency observations of Wolf–Rayet stars was analyzed. A description of TT Arietis is given. It is concluded that this object must be a double star, since it does not radiate like an ordinary photosphere or a single blackbody. Details of the spectrum are given. (STAR)

41587 PECULIARITIES OF QUASAR RED SHIFTS AND HYPOTHESES TO EXPLAIN THEM. Kipper, A. pp 3-45 of Peculiarities of Quasar Red Shifts and Hypotheses to Explain Them. /Kipper, A. Tartu; Tartuskaya Astrofizicheskaya Observatoriya (1971).

A hypothesis is presented according to which the redshift of the spectral lines of distant cosmic objectives can be explained as a continuous flow of the energy of photons to the cosmological vacuum. The decrease of the energy takes place with the decrease in the frequency. The quantum theory of electromagnetic waves based on the hypothesis, enables to explain why (1) the values z of absorption-line redshifts of several quasars are nonunique; (2) the values of z derived from absorption lines accumulate around the quantity $z = 1.95$; (3) there are only a few cosmic objects with redshift $z > 2$; (4) the correlation between radio brightness and the value of z is weak or missing especially in the case of quasars with weak radio brightness. (auth)

41588 PROPAGATION OF MONOCHROMATIC RADIO WAVES THROUGH INTERPLANETARY PLASMA. Efimov, A. I.; Yakovlev, O. I. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 16: No. 9, 1425-33(Sep 1971).

Translated from Radiotekh. Elektron.; 16: No. 9, 1554-63(Sep 1971).

Fluctuations of phases and amplitudes and the frequency spectrum of radio waves propagating through the interplanetary space are determined. The computed values of amplitude fluctuations are compared with experimental data. (auth)

41589 3C QUASI-STELLAR OBJECTS AND BRIGHT GALAXIES. Hazard, C.; Sanitt, N. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astrophys. Lett.; 11: No. 2, 77-82(Jun 1972).

The suggestion by Burbidge et al. that the correlation between the positions of 3C quasi-stellar objects and bright galaxies provides evidence of a local class of QSO's is examined by the use of other source and galaxy lists. These studies failed to reveal any similar correlation. It is shown the results of the two investigations are difficult to reconcile on the assumption that the 3CR–QSO galaxy correlation has any physical significance. (auth)

41590 RADIO SOURCES IN THE OHIO SURVEY AND ZWICKY COMPACT GALAXIES. Warner, John W. (Ohio State Univ., Columbus. Perkins Observatory, Delaware, Ohio). Astrophys. Lett.; 11: No. 2, 83-6(Jun 1972).

Significant coincidences are found between a sample of radio sources listed by the Ohio Survey and Zwicky's lists of compact galaxies. Positions of 21 Zwicky objects differ from the radio source positions by one standard deviation or less, although coincidences for only 8 of these 21 would be expected by chance. Finding charts, not previously published, are given for 19 objects. (auth)

41591 INFRARED PHOTOMETRY OF THE H II REGION SHARPLESS 266. Frogel, Jay A. (Harvard Coll. Observatory, Cambridge, Mass.); Persson, S. Eric; Kleinmann, D. E. Astrophys. Lett.; 11: No. 2, 95-7(Jun 1972).

Photometric observations at wavelengths between 1 and 10 μm of the small H II region Sharpless 266 are presented. At 2.2 and 3.5 μm, the flux emanates from a region smaller than 5 arc sec in diameter, less than one-tenth the size of the optical nebula, and coincident within 2 arc sec with a central stellar object. This flux has been interpreted as being due to either free–free emission at $T_e \sim 3500$ K, or thermal radiation from optically thin dust. Image-tube spectra show that the extended region is of low excitation and that the central object has a bright continuum and strong emission lines. (auth)

41592 HIGH-RESOLUTION OBSERVATIONS OF HIGH-VELOCITY NEUTRAL HYDROGEN CLOUDS. Verschuur,

G. L. (National Radio Astronomy Observatory, Green Bank, W. Va.); Cram, T.; Giovanelli, R. Astrophys. Lett.; 11: No. 2, 57-61(Jun 1972).

The discovery of very small-scale velocity and angular structure in high-velocity neutral hydrogen clouds considerably changes the estimates of the parameters of these clouds and the conditions under which they may be stable entities. (auth)

41593 PULSAR TIMING RESIDUALS. Michel, F. Curtis (Rice Univ., Houston, Tex.). Comments Astrophys. Space Phys.; 4: No. 2, 47-52(Mar-Apr 1972).

The phase residuals for the Crab and Vela pulsars are considered and mechanisms for these residuals are discussed. Slowing down of the pulsars is briefly discussed. (W.D.M.)

41594 PERIODICITY OF 3C 273. Wheeler, J. C. (California Inst. of Tech., Pasadena. Harvard Coll. Observatory, Cambridge, Mass.). Nature (London) Phys. Sci.; 237: No. 76, 102-4(12 Jun 1972).

The conflicting opinions regarding the possible periodicity of this quasar are reviewed. The Lebeder group (USSR) maintains that evidence exists for a nine-year quasi-periodic luminosity component, whereas other authors express doubt. The present author does not commit himself, but in his review it becomes apparent that few investigators had a clear idea of the basis for the claims of the Lebeder group. The results of application of the Lebeder method to various versions of the 3C 273 data are given, and a critical discussion of the claims for periodicity based on this method is presented. In particular the manner by which the period is claimed to be established is not explicit in the Lebeder papers. (UK)

41595 ANOMALOUS MINIMA IN CEN X-3. Margon, B.; Bowyer, S.; Lampton, M.; Gruddace, R. (Univ. of California, Berkeley). Nature (London) Phys. Sci.; 237: No. 76, 104(12 Jun 1972).

It is stated that a curious feature of satellite observations of the highly variable pulsing binary x-ray source Cen X-3 is that on several occasions the source remained at intensity minimum during periods when maxima were predicted, and this anomalous behavior must be explained before a detailed model can be formulated for the source. An observation is reported that was made with a rocket-borne Ar$-$CH$_4$ proportional counter, having a Mylar window and sensitive to x rays of 0.2 to 10 keV; apparently a flux upper limit compatible with the low-intensity period was observed during a predicted high-intensity interval. It is concluded that this anomalous effect is intrinsic to the source; also that occasional large variations in the radius of the envelope of matter surrounding the central object may account for the anomalous x-ray minima. The effect may greatly help in the optical identification of the Cen X-3 system. (UK)

41596 X-RAY SKY. Schnopper, Herbert W.; Delvaille, John P. (Massachusetts Inst. of Tech., Cambridge). Sci. Amer.; 227: No. 1, 27-38(Jul 1972).

Instrumental developments in x-ray astronomy are reviewed and models for x-ray sources are discussed in detail. (W.D.M.)

41597 EVIDENCE FOR SPATIALLY INDEPENDENT OUTBURSTS IN COMPACT RADIO SOURCES. Dent, William A. (Univ. of Massachusetts, Amherst). Astrophys. J.; 175: No. 2, L55-8(15 Jul 1972).

Observations of the 7.8-GHz flux-density variations of 3C 120 suggest that the apparent superrelativistic expansion of this source and others can be explained as being due to independent spatially separated radio outbursts. If confirmed, this result would establish that the energy generated in quasi-stellar sources is released in many separate independent outbursts rather than by repeated eruptions in a single supermassive object. (auth)

41598 INTERFEROMETRIC POSITIONS OF THE WATER-VAPOR EMISSION SOURCES IN H II REGIONS. Hills, Richard; Janssen, Michael A.; Thornton, Douglas D.; Welch, William J. (Univ. of California, Berkeley). Astrophys. J.; 175: No. 2, L59-64(15 Jul 1972).

An interferometer was constructed to operate at wavelengths as short as 1 cm. The positions of sources of strong water-vapor emission in the H II regions W3, W49, W51, and Orion A were measured. The water sources lie close to, but not always coincident with, the OH and other molecular sources and infrared objects. In some cases the water sources are clearly separated from the compact H II regions. (auth)

41599 COSMIC-RAY HEATING OF LOW-DENSITY INTERSTELLAR H II REGIONS. McCray, Richard; Buff, James (Univ. of Colorado, Boulder). Astrophys. J.; 175: No. 2, L65-8(15 Jul 1972).

If the interstellar medium is heated by a steady flux of low-energy cosmic rays, then H II regions of density $\lesssim 10^{-2}$ cm^{-3} and temperature $\gtrsim 3 \times 10^5$ °K are likely to occur in and above the galactic disk. (auth)

41600 OPTICAL STUDIES OF UHURU SOURCES. II. IM NORMAE, A POSSIBLE X-RAY SOURCE. Elliot, J. L. (Smithsonian Astrophysical Observatory, Cambridge, Mass.); Liller, William. Astrophys. J.; 175: No. 2, L69-72(15 Jul 1972).

It was discovered that the ex-nova IM Normae lies within the 90% confidence error-box surrounding the x-ray source 2U 1536$-$52. Following a discussion of the light curve of IM Nor, several lines of evidence are presented suggesting that at least one type of nova phenomenon can give rise to observable x-ray emission. (auth)

41601 SOFT X-RAYS FROM CYGNUS X-2 AND FROM CYGNUS X-1 (IN ECLIPSE). Stevens, J. C.; Garmire, G. P.; Riegler, G. R. (California Inst. of Tech., Pasadena). Astrophys. J.; 175: No. 2, L73-7(15 Jul 1972).

Cygnus X-1 and Cygnus X-2 were observed on October 23, 1971. The intensity of Cyg X-1 was in a low state at the time of observation, which corresponded to the time of possible eclipse of the companion of BD + 34°3815 (HDE 226868). The intensity of Cyg X-2 was measured to be comparable to previous observations, with an interstellar cutoff corresponding to $0.8 \pm 0.4 \times 10^{21}$ H atoms per cm^2. (auth)

41602 PULSE-HEIGHT DISTRIBUTION FOR NP 0532. Argyle, Edward; Gower, J. F. R. (Dominion Radio Astrophysical Observatory, Penticton, B. C.). Astrophys. J.; 175: No. 2, L89-91(15 Jul 1972).

The main pulses from the Crab pulsar at 146 MHz are distributed according to a power law with an exponent of -2.5. (auth)

41603 OBSERVATIONS AT 408 MHz OF RADIO SOURCES FROM THE 4C CATALOGUE. IV. DECLINATION RANGE 20^0 TO 6^0. Munro, R. E. B. (Univ. of Sydney). Aust. J. Phys., Astrophys. Suppl.; No. 22, 1-51(May 1972).

Radio positions and flux densities measured at 408 MHz with the Molonglo radio telescope are given for 1392 sources from the Fourth Cambridge catalogue in the declination range 20° to 0°. The mean spectral indices between 178 and 408 MHz are also considered in the light of these improved flux densities. (auth)

41604 WEAK ELECTROMAGNETIC FIELDS AROUND A ROTATING BLACK HOLE. Fackerell, Edward D.; Ipser, James R. (California Inst. of Tech., Pasadena). Phys. Rev., D; 5: No. 10, 2455-8(15 May 1972).

Foundations are laid for studying weak electromagnetic fields around a rotating black hole. In particular, Maxwell's equations in the Kerr geometry of the black hole are reduced to a single second-order partial differential equation. Although this differential equation is probably not separable, it is sufficiently simple to yield theorems about electromagnetic properties of black holes. (auth)

Solar Phenomena

Refer also to abstract 42043.

41605 TIME BEHAVIOR OF Ca II K_{2v} SPECTRAL FEATURES IN NONMAGNETIC REGIONS OF THE SOLAR DISK. Liu, S. Y. (Univ. of Maryland, College Park); Sheeley, N. R. Jr.; Smith, Elske v. P. Solar Phys.; 23: No. 2, 289-91(Apr 1972).

It is well known that under high spatial resolution the core of the Ca II K-line profile is often single peaked on the violet in "quiet" regions of the solar disk. These features have been called "cell points" (Liu and Smith(1971)), alluding to the fact that these occur in the nonmagnetic regions enclosed by the chromospheric network rather than in the strong-field network boundaries themselves. Although it is generally recognized that the lifetimes of these cell points are short, no systematic quantitative study of their temporal properties has yet been reported. Some preliminary results of such a study are reported. (W.D.M.)

41606 FREQUENCY DRIFT AND TIME SPLITTING OF DECAMETER SOLAR RADIO BURSTS. Sastry, Ch. V. (Indian Inst. of Astrophysics, Kodaikanal). Astrophys. Lett.; 11: No. 2, 47-51(Jun 1972).

The frequency drift and time splitting of solar radio bursts were observed with a multi-channel radiometer and a polarimeter at frequencies around 25 MHz. It was found that a majority of noise storm bursts have drift rates between +1.0 and -1.0 MHz/sec. Two types of unusual bursts with frequency drift are described.

The two components of a double burst were found to be polarized to the same degree and in the same sense. (auth)

41607 EFFECT OF STOCHASTIC MAGNETIC FIELDS ON ABSORPTION LINES. Dolginov, A. Z.; Pavlov, G. G. (Ioffe Inst. of Physics and Tech., Leningrad). Astrophys. Lett.; 11: No. 2, 63-9(Jun 1972).

The passage of light through an optically thin gas layer in a stochastic magnetic field is considered. Formulas connecting the profiles of four Stokes parameters of the incident and transmitted light are obtained. It is shown that the nonpolarized component in the sunspot umbra located in the disk center can be explained by the available stochastic magnetic field. (auth)

41608 MEASURING SOLAR PHOTOSPHERIC MAGNETIC FIELDS. Livingston, W. C. (Kitt Peak National Observatory, Tucson, Ariz.). Sky Telesc.; 43: No. 6, 344-9(Jun 1972).

The developments in solar magnetic field measurements since 1900 are reviewed and the present capabilities in this field are discussed. (W.D.M.)

41609 CORRELATION STUDIES OF SOLAR X-RAY AND RADIO BURSTS. McKenzie, David L. (Univ. of California, San Diego). Astrophys. J.; 175: No. 2, 481-92(15 Jul 1972).

Solar x-ray bursts observed by the UCSD OSO-III instrument between March 9, 1967 and Jan. 31, 1968 are studied using a sample of more than 300 bursts having associated microwave emission. Spectral observations suggest that x rays and associated microwave emission early in flare events arise from nonthermal electron distributions. Studies of the time development of x-ray and microwave bursts support a model in which soft x rays arise from a Maxwellian electron distribution heated by collisional energy loss of energetic electrons. Under this assumption an estimate of ambient ion density in the x-ray region of 10^{10} to 10^{11} cm^{-3} is derived. (auth)

41610 SOLAR SPECTRUM: WAVELENGTHS AND IDENTIFICATIONS FROM 60 TO 385 ANGSTROMS. Behring, W. E. (Goddard Space Flight Center, Greenbelt, Md.); Cohen, Leonard; Feldman, Uri. Astrophys. J.; 175: No. 2, 493-523(15 Jul 1972).

The solar spectrum from 60 to 158 Å and 163 to 385 Å was photographed at a resolution of 0.04 Å or better on glass plates. The wavelengths of emission lines in these records were determined with a typical accuracy of 0.008 Å above 100 Å and 0.004 Å below 100 Å. The spectrograph employed a 3-meter radius, 1200 grooves mm^{-1} gold grating at grazing incidence. The design considerations and limitations of this instrument are presented along with a description of the Aerobee 150 flight mission on May 16, 1969. The wavelengths for the 370 observed lines are listed together with intensity estimates. Of these, the 180 identified lines are due to ions of He, O, Ne, Mg, Si, S, Ar, Ca, Fe, and Ni. These identified lines are also tabulated separately for each isoelectronic sequence from Li I to K I. The solar lines are well enough resolved that wavelength determinations to ±0.004 Å can be made whenever better laboratory wavelengths become available. The reliability of the solar line "identifications" could then be much improved. (auth)

41611 STUDY OF D_3 EMISSION IN A SOLAR FLARE BY USE OF NARROW-BAND FILTERGRAMS. Milkey, Robert W. (Kitt Peak National Observatory, Tucson, Ariz.); Harvey, Karen L. Publ. Astron. Soc. Pac.; 84: No. 499, 400-5(Jun 1972).

Observations are reported of helium D_3 emission in the solar flare of February 11, 1970 made at the Lockheed Solar Observatory. The morphological relationship between the D_3 and Hα emission is explored, and a photometric reduction technique is applied to the filtergrams to determine peak intensity of the D_3 emission relative to the local quiet Sun continuum. (auth)

41612 IDENTIFICATION OF THE 1-0 AND 2-1 BANDS OF HCl IN THE INFRARED SUNSPOT SPECTRUM. Hall, Donald N. B. (Kitt Peak National Observatory, Tucson, Ariz.); Noyes, Robert W. Astrophys. J.; 175: No. 2, L95-7(15 Jul 1972).

Observations of the infrared umbral spectrum between 2400 and 3000 cm^{-1} permitted positive identification of 14 lines of the fundamental vibration–rotation bands of HCl. A preliminary solar ^{35}Cl abundance of $\log_{10}N(^{35}\mathrm{Cl}) = 5.4 \pm 0.3$ [on a scale where $\log_{10}N(\mathrm{H}) = 12$] was obtained. Several weak features are consistent with the presence of ^{37}Cl with a terrestrial abundance ratio. (auth)

41613 USE OF A CO_2 LASER TO PREPARE CHONDRULE-LIKE SPHERULES FROM SUPERCOOLED MOLTEN OXIDE AND SILICATE DROPLETS. Nelson, Lloyd S. (Sandia Labs., Albuquerque, N. Mex.); Blander, Milton; Skaggs, Samuel R.; Keil, Klaus. Earth Planet. Sci. Lett.; 14: No. 3, 338-44(Apr 1972).

Chondrule-like spherules were formed from individual freely falling subcooled droplets of alumina, enstatite, forsterite, enstatite–albite, and forsterite–albite mixtures that had been melted with a focused continuous CO_2 laser beam. Their textures (rimmed, excentro-radial, barred, glassy) are strikingly similar to those of many meteoritic chondrules. It is suggested that the phenomena associated with rapid crystallization from the supercooled melt are responsible for the various textures observed in the artificial spherules as well as in similar meteoritic chondrules. Although the experiments involve fast crystallization of rapidly cooling molten droplets in an ambient medium of low temperature and, hence, resemble the conditions that might apply to chondrule formation by small-scale thermal events produced by, for example, volcanism, impact splattering or electrical discharge processes, it is suggested that the textures observed would also result from rapid crystallization of relatively slowly cooling molten droplets that may have been produced in larger scale events, including condensation from a nebula of solar composition and solidification in an ambient medium of high temperature. (auth)

Galaxies

41614 EJECTION OF MASSIVE OBJECTS FROM GALACTIC NUCLEI: INTERACTIONS BETWEEN THE MASSIVE OBJECT AND THE GALACTIC GAS. Saslaw, William C. (Univ. of Virginia, Charlottesville); De Young, David S. Astrophys. Lett.; 11: No. 2, 87-93(Jun 1972).

The general dynamics and the x-ray and optical radiation associated with a massive object moving supersonically through a galaxy are discussed. A blackbody or a spinar type model for the object can produce a long luminous trail when the wake is heated by cosmic rays or when the ionization front acts as a catalyst for star formation. The results are applied to Markarian 205 and suggest that it may be a supermassive star of ~10^4 to 10^5 $M_\odot$, radius ~10^{14} to 10^{15} cm, and effective surface temperature ~20,000 K, based on Arp's observations of NGC 4319 and the bridge to Markarian 205. (auth)

41615 EXPANSION OF THE GALAXY. Field, G. B.; Rees, M. J.; Sciama, D. W. (Cambridge Univ., Eng.). pp 29-32 of Significance of Space Research for Fundamental Physics. /Moore, A. F. (ed.). Neuilly-sur-Seine, France; European Space Research Organization (1971).

From Conference on the significance of space research for fundamental physics; Interlaken, Switzerland (4 Sep 1969).

The gravitational-wave experiments carried out by Weber are briefly reviewed and his recent claim, that the analysis of the radiation is much improved when using sidereal time and that it could all come from one direction, is discussed. Kerr's studies of the rotation curve of the Galaxy are also discussed and it is suggested that there is a mass loss in the Galaxy of 70 solar masses per year, averaged over the last 10^8 years, due to gravitational radiation arising from catastrophic phenomena so far not understood. (France)

41616 FORMATION OF INTERSTELLAR MOLECULAR HYDROGEN. Lee, T. J. (Royal Observatory, Edinburgh. Culham Lab., Abingdon, Eng.). Nature (London) Phys. Sci.; 237: No. 76, 99-100(12 Jun 1972).

It is suggested that combination of hydrogen atoms on ice-coated grains can take place at temperatures above 20 K in the absence of enhanced binding sites. (auth)

41617 COMPARISON BETWEEN THE EMISSION-LINE GALAXIES NGC 5253 AND NGC 5408. Bohuski, T. J. (Univ. of Wisconsin, Madison. Cerro-Tololo Inter-American Observatory, La Serena, Chile); Burbidge, E. M.; Burbidge, G. R.; Smith, M. G. Astrophys. J.; 175: No. 2, 329-33(15 Jul 1972).

It is shown that the nuclear region of the irregular galaxy NGC 5408 is made up of large H II regions which have similar structures, electron densities, and temperatures to those found in the nucleus of the peculiar galaxy NGC 5253. Interferometric measurements give most probable velocities (velocity dispersions) of 23 and 30 km s^{-1} for the gas in the nuclei of NGC 5408 and NGC 5253, respectively. These velocities are similar to those found in giant H II regions in other galaxies which have been studied by the same method. The heliocentric radial velocities are found to be 505 and 396 km s^{-1} for NGC 5408 and NGC 5253, respectively. The nitrogen abundance relative to hydrogen is probably lower in NGC 5408 than it is in NGC 5253. A brief discussion is given of possible ways of interpreting these results. (auth)

41618 INTERNAL KINEMATICS OF TWO COMPACT GALAXIES. O'Connell, Robert W., Kraft, Robert P. (Univ. of California, Santa Cruz). Astrophys. J.; 175: No. 2, 335-45(15 Jul 1972).

Spectrograms of two compact galaxies, I Zw 129 and II Zw 70, taken in several position angles have been obtained with a Varo-type image tube at the coudé focus of the 120-inch (305 cm) reflector. The velocity dispersion in each object is of order 25 km s^{-1}, and no evidence for unusual gas motions is found. A rotation curve for I Zw 129 is obtained, from which a total mass of $4.1 \times 10^9\ \mathfrak{M}_\odot$ and a mean mass density $\rho \sim 0.4\ \mathfrak{M}_\odot\ pc^{-3}$ are found. Scanner observations lead to an unusually low mass-to-light ratio $\mathfrak{M}/L_V = 0.18\ \mathfrak{M}_\odot/(L_V)_\odot$ and an unusually high ratio of ionized gas to total mass which may be as large as $\mathfrak{M}_{H\,II}/\mathfrak{M}_{total} = 0.07$. The observations indicate that the initial luminosity function for star formation in I Zw 129 does not resemble that in the solar neighborhood. Data for II Zw 70 are not as extensive, but they suggest that its mass-to-light ratio and mean mass density are similar to those of I Zw 129. (auth)

41619 HIGH-VELOCITY NEUTRAL HYDROGEN IN THE CENTRAL REGION OF THE ANDROMEDA GALAXY. Whitehurst, Robert N. (Univ. of Alabama, Tuscaloosa); Roberts, Morton S. Astrophys. J.; 175: No. 2, 347-52(15 Jul 1972).

Hydrogen-line radiation reaching a radial velocity of −540 km s^{-1} is observed from the central region of Andromeda. This corresponds to −230 km s^{-1} with respect to the systemic radial velocity. A positive wing is also seen, but its extent cannot be determined because of confusion with foreground Galactic hydrogen. The possibility that antenna beam smearing is responsible for this feature can be rejected. To explain the large velocity range, models involving a rapidly rotating disk, z-motion, or planar radial streaming are considered. The present data do not allow differentiation among these models, although broad constraints can be placed on them. (auth)

41620 EQUILIBRIUM CONFIGURATION OF THE GASEOUS COMPONENT OF THE GALAXY. Kellman, Sanford A. (Univ. of Maryland, College Park. Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 175: No. 2, 353-62(15 Jul 1972).

The distribution of gas satisfying hydrostatic and Poisson conditions with distance above the galactic plane is derived and compared with Schmidt's observations of the gas density $\rho_g(z)$. Magnetic ($B^2/8\pi$) and cosmic-ray (P_{cr}) components constrained to vary like the gas pressure are assumed. The density $\rho_g(z)$ is calculated for two limiting cases: (i) the total mass density at the galactic plane $\rho_{g0} + \rho_{*0}$ is equal to the sum of the observed gas and star densities in the solar neighborhood (0.089 $M_\odot\ pc^{-3}$), and (ii) Oort's data on the z-component of the galactic gravitational acceleration K_z is used, in which case it is implicitly assumed that $\rho_{g0} + \rho_{*0} = 0.15\ M_\odot\ pc^{-3}$. Using recently observed values for B_0, P_{cr0}, and ρ_{g0}, the rms z turbulent velocity dispersion $\langle v_{tz}^2 \rangle^{1/2}$ of the gas is determined. An expression is derived for the half-thickness $z_{1/2}$ of the equilibrium disk of galactic gas: $z_{1/2} \propto Q/(\rho_{g0} + \rho_{*0})^{1/2}$, where $Q^2 = \langle v_{tz}^2 \rangle + B_0^2/8\pi\rho_{g0} + P_{cr0}/\rho_{g0}$. Using the Innanen galactic mass model, the half-thickness is computed as a function of distance from the galactic center over the range 4 kpc ≤ R ≤ 14 kpc and compared to the observations of McGee and Milton. The observed increase in half-thickness at distances beyond the solar distance R_0 is reproduced theoretically. Because $z_{1/2}$ is observed to remain essentially constant in the region 4 kpc ≤ R ≤ R_0, Q increases like $(\rho_{g0} + \rho_{*0})^{1/2}$ with decreasing R. (auth)

41621 STABILITY OF A SELF-GRAVITATING, NONROTATING GAS LAYER WITH STELLAR, MAGNETIC, AND COSMIC-RAY COMPONENTS. I. Kellman, Sanford A. (Univ. of Maryland, College Park. Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 175: No. 2, 363-71(15 Jul 1972).

A time-independent linear stability analysis is performed on a self-gravitating, plane-parallel, isothermal layer of nonrotating gas with magnetic and cosmic-ray components. The gas layer is immersed in a plane-stratified isothermal layer of stars which supply a self-consistent gravitational field; however, only the gaseous component is perturbed. The stability of the gas layer is considered with respect to waves with motions perpendicular to the (B_e,g_e)-plane (longitudinal compressions perpendicular to B_e), where B_e and g_e are the equilibrium magnetic and gravitational field vectors. The equation governing the size of the perturbations in the midplane is found to be analogous to the one-dimensional time-independent Schroedinger equation for a particle bound by a potential well, and with similar boundary conditions. The radius of the neutral or marginally unstable state is computed numerically and compared with the Jeans and Ledoux radii. The principal result to emerge from this study is that the magnetic field and cosmic-ray gas hinder gravitational instability, increasing the minimum length necessary to produce instability by the factor $(1 + \alpha + \beta)^{1/2}$, where α is the ratio of magnetic pressure to gas pressure and β is the ratio of cosmic-ray pressure to gas pressure. The possibility is discussed that gravitational instability of the gaseous component in the outer regions of galaxies excites density waves of the type described by Lin. (auth)

41622 CONTRIBUTION OF TRANSITION RADIATION FROM DUST GRAINS TO THE DIFFUSE X-RAY BACKGROUND. Lerche, I. (Univ. of Chicago). Astrophys. J.; 175: No. 2, 373-7(15 Jul 1972).

It is shown that the transition radiation produced in the band 0.1 keV to ~100 keV by cosmic-ray electrons bombarding interstellar dust grains produces a significant fraction of the observed diffuse x-ray background radiation. (auth)

41623 MODELS AND MASS ESTIMATES FOR IONIZED INTERGALACTIC GAS IN THE COMA CLUSTER. Welch, Gary A.; Sastry, Gummuluru N. (Wesleyan Univ., Middletown, Conn.). Astrophys. J.; 175: No. 2, 323-8(15 Jul 1972).

Comparison is made of the ability of thermal, synchrotron, and inverse Compton mechanisms to match currently available observations of diffuse radiation (apparent dimension ~45′) in the central region of the Coma cluster. The synchrotron mechanism encounters no difficulty in fitting the data at radio frequencies, but nonthermal mechanisms cannot provide the observed x-ray flux without the introduction of restrictive and implausible conditions. If the diffuse optical source reported earlier is due to thermal bremsstrahlung from a region of dimension ~45′, then it appears difficult to supply the radiating gas with energy sufficient to prevent rapid cooling. However, if intergalactic stars provide the optical radiation or if it represents ejecta from the nearby giant galaxy NGC 4874, then a plausible model is one incorporating the radio synchrotron source proposed by Willson and a hot plasma suggested as a possible source of the x radiation by Gursky et al. In any case the total mass needed to satisfy the observations in the frequency range $7 \lesssim \log \nu \lesssim 18$ is on the order of 3 to 4×10^{13} $M_\odot$, much less than the virial mass of the cluster. (auth)

41624 DARK NEBULAE IN THE LARGE MAGELLANIC CLOUD. Hodge, Paul W. (Univ. of Washington, Seattle). Publ. Astron. Soc. Pac.; 84: No. 499, 365-72(Jun 1972).

Schmidt plates in three colors from the Curtis and ADH Schmidt telescopes were searched for dark nebulae. Positions, dimensions, and photometric properties are given for 68 identified dark nebulae. They are generally larger than the well-known examples in the Milky Way. Many show alignment with the bar, and there is a strong suggestion of an elongation of the dust clouds parallel to the magnetic field. (auth)

41625 BRIGHTNESS VARIATIONS IN THE NUCLEUS OF THE SEYFERT GALAXY NGC 6814. MacPherson, Glenn J. (Univ. of California, Santa Cruz). Publ. Astron. Soc. Pac.; 84: No. 499, 392-3(Jun 1972).

Photometry of Seyfert galaxies indicates that the nuclei fluctuate irregularly in optical brightness, particularly in the ultraviolet region of the spectrum. To see if this behavior is true of NGC 6814, UBV photoelectric photometry was done in the summer of 1970. (W.D.M.)

41626 FRAGMENTATION OF A CONCENTRATING HYDROGEN CLOUD IN AN EXPANDING UNIVERSE. Yoneyama, Tadaoki (Tokyo Univ.). Publ. Astron. Soc. Jap.; 24: No. 1, 87-98(Jan 1972).

The gravitational contraction and the fragmentation of a pure hydrogen gas cloud in an expanding universe are studied. A cloud contracts adiabatically at the initial phase, but at a later phase, hydrogen molecules are formed in the cloud and they act as an effective cooling source. In this cooling stage, the evolutionary track depends little on the initial conditions and on mass of the cloud. As the contraction proceeds, fragmentation takes place in the cloud, and massive stars with masses greater than 60 $M_\odot$ will be formed. (auth) (Japan)

Cosmology

Refer also to abstracts 41883 and 42006.

41627 PECULIARITIES OF QUASAR RED SHIFTS AND HYPOTHESES TO EXPLAIN THEM. Kipper, A. Tartu; Tartuskaya Astrofizicheskaya Observatoriya (1971). 60p.

Bound with PRESSURE IN INHOMOGENEOUS WORLD MODELS by E. Saar.

Separate abstracts were prepared for the two parts. (W.D.M.)

For abstracts of individual sections see: 41587 and 41628.

41628 PRESSURE IN INHOMOGENEOUS WORLD MODELS. Saar, E. pp 47-58 of Peculiarities of Quasar Red Shifts and

Hypotheses to Explain Them. /Kipper, A. Tartu; Tartuskaya Astrofizicheskaya Observatoriya (1971).

To make the theory of inhomogeneous cosmological models more realistic physically, pressure terms are included. It is noted that even in a radiation-free Universe pressure has to be introduced to describe appropriately the evolution of star systems. This pressure is due to random motions of stars. An approximate equation of state for the present stage of the Universe is proposed and some possibilities of its refinement are discussed. (auth)

41629 EPPUR SI MUOVE. Sciama, D. W. Comments Astrophys. Space Phys.; 4: No. 2, 35-9(Mar-Apr 1972).

A recent attempt by Henry (1971) to measure the velocity of the Earth through the microwave background prompted a survey of the implications of such measurements. A number of different attempts to measure some kind of velocity for the Earth are listed and discussed. (W.D.M.)

41630 ABOUT THE RADIATION OF ELECTROMAGNETIC AND GRAVITATIONAL WAVES BY THE SOURCES MOVING WITH VELOCITY GREATER THAN VELOCITY OF LIGHT IN A VACUUM. Ginzburg, V. L. Comments Astrophys. Space Phys.; 4: No. 2, 41-6(Mar-Apr 1972).

It is concluded that superlight sources are not only of physical interest but can be encountered in astrophysics. It is felt useful to consider the existence and peculiarities of such sources. (W.D.M.)

41631 LIGHT OUT OF DARKNESS VS ORDER OUT OF CHAOS. Peebles, P. J. E. (Princeton Univ., N. J.). Comments Astrophys. Space Phys.; 4: No. 2, 53-8(Mar-Apr 1972).

The question is posed — in conventional general relativity theory can one make a consistent and reasonable picture for the evolution of the Universe starting from (a) chaos; (b) statistical homogeneity chaotic on the small scale; (c) detailed homogeneity and isotropy. The author's impression is that option (c) works and is needed. (W.D.M.)

41632 OBSERVATIONAL STATUS OF COSMOLOGICAL HELIUM. Searle, Leonard; Sargent, W. L. W. (Hale Observatories, Pasadena, Calif.). Comments Astrophys. Space Phys.; 4: No. 2, 59-64(Mar-Apr 1972).

Observations which relate to the helium content of pre-galactic matter are reviewed. It is shown that there is strong evidence that the bulk of the helium observed in the absorption spectra of young, hot stars in the Galaxy and in emission spectra of H II regions was already present when these objects formed. (W.D.M.)

41633 SIGNIFICANCE OF SPACE RESEARCH FOR FUNDAMENTAL PHYSICS. Conference Held at Interlaken, Switzerland, September 4, 1969. Moore, A. F.; Hardy, V. (eds.). Neuilly-sur-Seine, France; European Space Research Organization (1971). 175p. (ESRO-SP-52; CONF-690989).

The seven papers presented at this colloquim are concerned with the current work being carried out on General Relativity and many related topics, and discuss: space research and observational cosmology; the experimental determination of the spacetime metric; solar-system tests of gravitational theories; the cosmological significance of observations at far-infrared and millimeter wavelengths; the expansion of the Galaxy; theoretical background and present status of the Stanford relativity-gyroscope experiment. Finally, a greatly expanded version of the paper on relativistic cosmology and space platforms is given, in which the detailed discussion covers: physics of a superdense star; pulsars; supernovae; black holes; quasi-stellar objects; gravitational radiation; formation of galaxies; and the solar system as a testing ground for Relativity. (France)

For abstracts of individual papers see: 41615 and 41634–41639.

41634 SPACE RESEARCH AND OBSERVATIONAL COSMOLOGY. Sciama, D. W. (Cambridge Univ., Eng.). pp 5-8 of Significance of Space Research for Fundamental Physics. /Moore, A. F. (ed.). Neuilly-sur-Seine, France; European Space Research Organization (1971).

From Conference on the significance of space research for fundamental physics; Interlaken, Switzerland (4 Sep 1969).

Systematic artificial satellite observations of quasars and of the possible extragalactic background radiation at a variety of frequencies are now required in order to make further progress in these subjects. Intergalactic absorption effects might be detected by making ultraviolet observations of the continuous spectra of galaxies and quasars. The redshift of the intergalactic gas would produce an absorption trough. The resonance scattering by helium should also be measured, as the helium/hydrogen ratio in the intergalactic medium would help to settle several problems. The O VI resonance transition at 1031 A in intergalactic space should also be investigated. (France)

41635 EXPERIMENTAL DETERMINATION OF THE SPACE-TIME METRIC. Blamont, J. (CNRS, Verrieres-le-Buisson, France). pp 9-15 of Significance of Space Research for Fundamental Physics. /Moore, A. F. (ed.). Neuilly-sur-Seine, France; European Space Research Organization (1971).

From Conference on the significance of space research for fundamental physics; Interlaken, Switzerland (4 Sep 1969).

The quadrupole moment of the Sun and general relativity tests giving values for β and γ are discussed. The tracking of a drag-free system on board a spacecraft in an eccentric heliocentric orbit and measurement of the transit length of an electromagnetic signal between the Earth and the spacecraft near superior conjunction are proposed for new measurements of β, γ, and J_2. (France)

41636 SOLAR-SYSTEM TESTS OF GRAVITATIONAL THEORIES. Shapiro, I. I. (Massachusetts Inst. of Tech., Cambridge). pp 17-21 of Significance of Space Research for Fundamental Physics. /Moore, A. F. (ed.). Neuilly-sur-Seine, France; European Space Research Organization (1971).

From Conference on the significance of space research for fundamental physics; Interlaken, Switzerland (4 Sep 1969).

The progress in ground-based tests of general relativity and the problems and prospects for corresponding spaceflight experiments are discussed. (France)

41637 COSMOLOGICAL SIGNIFICANCE OF OBSERVATIONS AT FAR-INFRARED AND MILLIMETRE WAVELENGTHS. Rees, M. J. (Cambridge Univ., Eng.). pp 23-8 of Significance of Space Research for Fundamental Physics. /Moore, A. F. (ed.). Neuilly-sur-Seine, France; European Space Research Organization (1971).

From Conference on the significance of space research for fundamental physics; Interlaken, Switzerland (4 Sep 1969).

Observations of the background spectrum around 1 mm wavelength should provide a crucial test of hot big-bang theories and may yield additional information on the early history of the expanding Universe. Apart from their fundamental importance for cosmology, observations from above the atmosphere in the 100 μ to 1 mm band will be of great relevance to astronomical studies of molecules and interstellar dust. (France)

41638 THEORETICAL BACKGROUND AND PRESENT STATUS OF THE STANFORD RELATIVITY-GYROSCOPE EXPERIMENT. Everitt, C. W. F.; Fairbank, W. M.; Schiff, L. I. (Stanford Univ., Calif.). pp 33-43 of Significance of Space Research for Fundamental Physics. /Moore, A. F. (ed.). Neuilly-sur-Seine, France; European Space Research Organization (1971).

From Conference on the significance of space research for fundamental physics; Interlaken, Switzerland (4 Sep 1969).

An earlier proposal that a measurement of the precession of the spin axis of a gyroscope moving through the Earth's gravitational field would provide a test of Einstein's general theory of relativity is discussed in terms of the Brans–Dicke theory and other recent developments. It is shown that an accuracy of 0.001 arc-second per year in the orientations of two or more gyroscopes is required which would also provide a rough measure of the quadrupole effect. The work of the last seven years at Stanford University on this project, including the large-scale low-temperature physics techniques and advanced techniques in electronic instrumentation and control theory, is discussed in detail. Parts of the laboratory prototype are being tested and it is hoped that a preliminary test flight will take place in 1973 or soon afterwards. (France)

41639 RELATIVISTIC COSMOLOGY AND SPACE PLATFORMS. Ruffini, Remo (Inst. for Advanced Study, Princeton, N. J.); Wheeler, J. A. pp 45-174 of Significance of Space Research for Fundamental Physics. /Moore, A. F. (ed.). Neuilly-sur-Seine, France; European Space Research Organization (1971).

From Conference on the significance of space research for fundamental physics; Interlaken, Switzerland (4 Sep 1969).

Einstein's standard 1915 general relativity or geometrodynamics introduces a new dynamical participant on the scene of physics: geometry. Nowhere did the dynamics of geometry originally show up more impressively than in the expansion of the Universe. Today the role of curved space geometry, both static and dynamic, lends itself to investigation from space platforms or from the ground, or both, in many other contexts; among them are: properties of a superdense or neutron star; pulsar physics; collapse of a star with big dense core to a superdense star in a supernova event, or complete collapse to a black hole; physics of the black hole; galactic centers, jets, and quasi-stellar sources; gravitational radiation; Misner's mixmaster model of the Universe; the primordial fireball radiation; the time scale of the expansion of the Universe; the Universe as a lens, magnifying the apparent diameter of a far-away galaxy; the mystery of the missing matter; the formation of galaxies; reaching out via radiation receptors for more information on the physics of these phenomena; and finally the solar system itself as a testing ground for relativity including the traditional three tests of relativity; the retardation of light as it passes close to the Sun on its way to Venus and back; relativistic effects in planetary motion and searches via corner reflectors on the Moon for relativistic effects in the motion of the Moon, as predicted by Baierlein. (France)

41640 QUARKS AS A THERMOMETER FOR COSMOLOGIES. Frautschi, Steven (California Inst. of Tech., Pasadena); Steigman, Gary; Bahcall, John Contract AT(11-1)-68. Astrophys. J.; 175: No. 2, 307-22(15 Jul 1972).

If physical quarks exist, their density relative to ordinary baryons (n_q/n_B) depends sensitively on the highest temperatures reached during cosmological evolution. Zel'dovich has pointed out that in the conventional hot big bang with a limited spectrum of elementary particles the quark density n_q/n_B predicted for the present time is much larger than the experimental upper bound. The consequences for conventional cosmologies of the Hagedorn type of hadron spectrum were derived which implies a "warm" limiting temperature of order $kT \approx 160$ MeV. With initial temperatures of this order, the predicted n_q/n_B is consistent with present experimental limits if the quark mass exceeds 9 GeV. In the Hagedorn model, quarks with $m_q > 9$ GeV would be very difficult to produce in accelerator experiments because of statistical competition; searches for fossil quarks in bulk matter seem to offer the only hope of detection. Predictions for the quark density in several less conventional cosmologies (mixmaster, Brans–Dicke, Lamaître, steady state, and Klein–Alfvén) and with forms of the hadron density of states that differ from Hagedorn's proposed form are discussed. (auth)

41641 STABILITY OF AXISYMMETRIC SYSTEMS TO AXISYMMETRIC PERTURBATIONS IN GENERAL RELATIVITY. I. THE EQUATIONS GOVERNING NONSTATIONARY, STATIONARY, AND PERTURBED SYSTEMS. Chandrasekhar, S.; Friedman, John L. (Univ. of Chicago). Astrophys. J.; 175: No. 2, 379-405(15 Jul 1972).

Axisymmetric systems in general relativity are considered. The field and the fluid equations that are appropriate to general nonstationary (but axisymmetric) systems are first derived. They are then specialized to yield the equations which govern stationary equilibrium. The equations which determine the evolution of small departures from equilibrium are also obtained. Related matters that are considered include the Landau–Lifshitz complex, the conserved quantities, and the constancy of the baryon number and the angular momentum (per baryon) of a fluid element as it moves. The theory is developed with a view toward establishing criteria for the stability of rotating systems to axisymmetric perturbations. (auth)

41642 HOOKE'S SYMMETRIES AND NONRELATIVISTIC COSMOLOGICAL KINEMATICS. I. Derome, J.-R. (Univ. of Montreal); Dubois, J.-G. Nuovo Cim.; 9B: No. 2, 351-76 (11 Jun 1972).

The structure of the Hooke groups and of their central extensions was studied and compared with that of the Galilei group. The local exponents of the Hooke groups were obtained by integration of the Lie algebra. The invariants of the extended Hooke groups were deduced from the de Sitter's symmetries. The kinematical observables were identified with elements of their enveloping algebras and the constants of motion are given. Knowing that the main difference between the Hooke and Galilei kinematics can be accounted for by a harmonic potential, some indications for a Hooke cosmological model are proposed. (auth)

41643 POSSIBLE INTERPRETATION OF THE RED SHIFT OF SPECTRAL LINES OF ASTRONOMICAL OBJECTS. Pecker, Jean-Claude (CNRS, Paris); Vigier, Jean-Pierre; Roberts, Alan P. Compt. Rend., Ser. B; 274: No. 11, 765-8(13 Mar 1972). (In French).

The cosmological origin of redshift is again subject to serious questioning; an interpretation is suggested, taking into consideration the inelastic interactions between photons with nonzero proper mass, and an experiment is proposed that will either confirm or nullify this interpretation. (France)

41644 NON-LINEAR THEORY OF GRAVITATIONAL INSTABILITY IN THE EXPANDING UNIVERSE. III. Tomita, Kenji (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 2, 416-43(Feb 1972).

It is indicated that, at the radiation-dominated stage of the expanding Universe, two ways should be distinguished for the evolution of the second-order density waves most naturally associated with the first-order rotational and gravitational waves, and the behavior of an isolated eddy is examined for a comparison with those of periodically distributed eddies. The second-order waves associated with rotational density and their mixed waves at the intermediate stage (before and after the decoupling epoch t_D) are analyzed and the rapidity of compression due to the inertial force appearing soon after t_D is calculated. The possibility of galaxy formation is examined on the basis of the above analysis. Moreover a possibility for comparatively small galaxies to be formed through the cascade due to nonlinear process is considered. (auth)

41645 QUANTUM MODELS FOR THE LOWEST-ORDER VELOCITY-DOMINATED SOLUTIONS OF IRROTATIONAL DUST COSMOLOGIES. Liang, E. P. T. (Univ. of Texas, Austin). Phys. Rev., D; 5: No. 10, 2458-66(15 May 1972).

The lowest-order velocity-dominated solutions to the Einstein dust equations of Eardley, Liang, and Sachs are quantized using the canonical methods of DeWitt and of Arnowitt, Deser, and Misner. The quantum dynamics of these models is shown to be governed by the Einstein–Klein–Gordon (EKG) equation. Exact solutions of the decoupled EKG equations in the discrete limit are obtained, which have the striking feature that the state amplitude vanishes at the singularity for anisotropic models. The geometry of the manifold of the classical 3-metrics is studied and it turns out to be composed of conformally flat geodesic submanifolds. Other difficulties related to the quantum theory such as factor ordering, divergence, interpretation of the volume measure, etc. are also discussed. (auth)

Planetary Phenomena

Refer also to abstracts 42042 and 42043.

41646 SHEATH EFFECTS AND RELATED CHARGED-PARTICLE ACCELERATION BY JUPITER'S SATELLITE IO. Gurnett, Donald A. (Univ. of Iowa, Iowa City). Astrophys. J.; 175: No. 2, 525-33(15 Jul 1972).

Several current theories on the Jovian decametric radio emission, and its modulation by the satellite Io, assume that the plasma within the magnetic flux tube passing through Io is "frozen" to the motion of Io. This paper considers the effects of the plasma sheath around Io on the interaction of Io with the Jovian magnetosphere. It is found that under some conditions the plasma sheath around Io can effectively insulate the magnetospheric plasma from the motional electric field generated within Io, thus preventing the plasma from being frozen to the motion of Io. Under these conditions large potentials are developed across the plasma sheath and emitted photoelectrons can be accelerated to high energies. The sheath voltages which develop are controlled by the ionospheric conductivity at the base of the Io flux tube, as well as other plasma parameters at Io. A simplified model illustrating these basic effects is discussed. (auth)

41647 DETERMINATION OF THE ZONAL DISTRIBUTION OF ANGULAR VELOCITIES IN THE ANOMALOUS ROTATION OF SPHERICAL COSMIC BODIES. Stiegler, Karl. Compt. Rend., Ser. A; 274: No. 12, 1026-8(20 Mar 1972). (In French).

Arguments developed in a previous note are extended; a general method of determining the zonal distribution of the angular velocities of a spherical cosmic body is presented, the assumption that the angular equatorial velocity and the angular velocity near the equator are known, being made. The method is applied to Jupiter and Saturn. (France)

41648 UNIPOLAR INTERACTION OF MERCURY WITH THE SOLAR WIND: THE STEADY-STATE BOW SHOCK PROBLEM. Colburn, D. S. (Ames Research Center, Moffett Field, Calif.); Sonett, C. P.; Schwartz, K. Earth Planet. Sci. Lett.; 14: No. 3, 325-37(Apr 1972).

The steady-state electromagnetic interaction of the solar wind with the planet Mercury is computed for a spectrum of electrical-conductivity functions using the assumption that no atmosphere or planetary magnetic field prohibits the direct interaction. The form of the induction is described by the unipolar effect and corresponds to the zero-frequency limit of a transverse magnetic (TM) mode. Calculations are included to determine the effective surface temperature of the planet. These calculations include the apparent motion of the Sun in the Hermean sky. It is shown that a significant interaction, detectable by a space probe, is plausible for reasonable conductivity functions. The strength of the interaction is considered in terms of the subsurface thermal gradient, and computations are given relating the strength of the solar wind interaction with the conductivity parameters. (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

Refer also to abstracts 41674 and 42345.

41649 (WRE-TN-80(WR and D)) DISCUSSION OF AN APPARENT RELATIONSHIP BETWEEN OZONE DENSITIES ABOVE 25 KM AND GEOMAGNETIC ACTIVITY. Bowers, B. C. (Weapons Research Establishment, Salisbury (Australia)). Sep 1971. 11p. Dep. NTIS (U. S. Sales Only).

A comparison between satellite ozone contours for April 17 and 18, 1965, and constant L-shell parameters has revealed a number of similarities. During the collection of the ozone data a geomagnetic storm occurred that may have produced an area of depleted ozone over the South Pacific. Particle precipitation may have been responsible but this seems unlikely. Other possible causes are suggested but in turn each is rejected. A coincidental similarity between the ozone and L-shell contours cannot be ruled out until further observations have been made. (auth) (Australia)

41650 NITRIC OXIDE IN THE D REGION. Strobel, Darrell F. (Kitt Peak National Observatory, Tucson, Ariz.). J. Geophys. Res.; 77: No. 7, 1337-9(1 Mar 1972).

It was concluded that large NO densities on the order of 4×10^7 cm^{-3} are present throughout the upper mesosphere. However, in this theoretical analysis the branching ratios of the $N(^2D)$ sources (NO^+ recombination, electron dissociation of N_2, and the reaction $N_2^+ + O$) are parameters for which no laboratory constraints are available [cf. Strobel, 1971a]. In addition, the value chosen for the eddy diffusion coefficient κ was 4.5×10^6 cm^2 sec^{-1}, based on the $[O]/[O_2] \sim 1$ at 120 km [Colegrove et al., 1966]. One of the problems of D-region ion chemistry is the large production rate of NO^+ that leads to electron densities approximately a factor of 10 larger than observed electron densities when the laboratory value for the dissociative recombination coefficient is used to calculate the NO^+ loss rate. A number of calculations similar to those reported by Strobel [1971b] were performed to illustrate the implications of reduced κ in the upper mesosphere. (J.C.W.)

41651 INTERPLANETARY MAGNETIC-FIELD DIRECTION AND HIGH-LATITUDE IONOSPHERIC CURRENTS. Joergensen, T. Stockflet; Friis-Christensen, E.; Wilhjelm, J. (Danish Meteorological Inst., Charlottenlund, Denmark). J. Geophys. Res.; 77: No. 10, 1976-7(1 Apr 1972).

New investigations have established that the magnetic effects on the ground are associated with the east-west component of the interplanetary magnetic field rather than the directions away and toward, which usually correspond to eastward and westward, respectively. Dungey (1961) has described merging between meridional components of interplanetary and magnetospheric field lines. It is now assumed that merging between equatorial components of interplanetary and magnetospheric field lines takes place in an analogous way. When the Earth is in an away sector, the magnetospheric field lines in the cusp region will be dragged toward the dawn side of the northern auroral oval and toward the dusk side in the southern auroral oval. The ionospheric plasma in the northern and southern dayside auroral regions will move westward and eastward, respectively. When the Earth is in a toward sector, the process is similar, but the plasma drifts in the dayside auroral ovals, and the resulting currents and magnetic disturbances are now reversed in direction. (J.C.W.)

41652 EFFECT OF $\lambda < 10$-A SOLAR X RAYS ON THE IONOSPHERE BETWEEN 60 AND 100 km. Sengupta, P. R. (Univ. of Iowa, Iowa City). J. Inst. Telecommun. Eng., 15: No. 5, 305-28 (1969).

Computations are made in order to evaluate the ionospheric effects caused by the observed 10-A x-ray quiescent flux and flare flux. Of 72 solar x-ray flares having F(2 to 12 A) greater than 3×10^{-3} erg/cm² sec as recorded by the University of Iowa detector on Explorer 33, 67 are found to be accompanied by reported sudden ionospheric disturbances (SID's) in which the electron density of the ionosphere between 60 and 100 km undergoes a rapid increase during a few min. These rapid increases in electron density are presumably caused by the enhanced x-ray flux in the wavelength range $1 < \lambda < 10$ A because softer x ray would be completely absorbed above 100 km and harder x rays would penetrate below 60 km without a significant attenuation at higher altitudes. The altitudes for peak electron production range from 99 km for 10-A x rays down to 58 km for 1-A x rays. The electron production-rate equations are solved using a quiescent x-ray energy spectrum derived from the work of various observers during the past 9 yr. The physical and chemical processes involved in the mechanism of ionization of the local atmospheric constituents according to existing models are discussed. Distribution of the computed electron production rate and the resulting electron density variation with height are plotted for quiescent and flare conditions. These plots are compared with available experimental data. It is confirmed that the SID's can be explained quantitatively, assuming flare x rays as the only ionizing agent. The magnitude of the SID's depends on 0.10-A peak flux and flare spectrum. It is further shown that, under 1966 quiescent conditions, x ray ionization in the region under study is comparable to ionization by solar Lyman alpha. Solar Lyman-α flux is known to be very steady, varying by a factor not more than 2 between solar minima and solar maxima, while 1- to 10-A solar x-ray flux varies greatly with solar activity. Solar x rays of wavelength below 10 A are thus responsible for both rapid variations and day-to-day variations of the D-region electron density. The variation of the effective height of the D region with solar activity may also be traced to the variation of the 0- to 10-A solar x-ray flux. (Indian Sci. Abstr.)

41653 PAPERS PRESENTED AT COSPAR SYMPOSIUM ON D- AND E-REGION ION CHEMISTRY, URBANA, ILLINOIS, JULY 6-8, 1971. Radio Sci.; 7: No. 1, 1-213(Jan 1972). (CONF-710727).

Separate abstracts were prepared for 20 of the 23 papers presented at the conference on D- and E-region chemistry, July 6-8, 1971, Urbana, Illinois. The three remaining papers dealt with height distribution of minor neutral constituents, and were not considered in scope of NSA. (J.C.W.)

For abstracts of individual papers see: 41654–41673.

41654 IMPROVED PHOTOIONIZATION RATES OF $O_2(^1\Delta_g)$ IN THE D REGION. Paulsen, D. E.; Huffman, R. E.; Larrabee, J. C. (Air Force Cambridge Research Labs., Bedford, Mass.). Radio Sci.; 7: No. 1, 51-5(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

The recent discovery of relatively large concentrations of $O_2(^1\Delta_g)$ in the upper atmosphere had led to consideration of photoionization of this metastable molecule as a major source of O_2^+ in the D region. Initial calculations indicated that this process was less important than previously believed, primarily because of CO_2 absorption. The effect of various reasonable O_2, CO_2, and $O_2(^1\Delta_g)$ density profiles on the ion-production rates is considered. Within the limits described herein the ion-production rate (ion cm^{-3} sec^{-1}) is approximated by the following function of N_{O_2}, the O_2 column density in molecules per square-centimeter column, and $n_{1\Delta}$, the $O_2(^1\Delta_g)$ density in molecules per cubic centimeter: $P(O_2^+) = n_{1\Delta}[0.549 \times 10^{-9} \exp(-2.406 \times 10^{-20} N_{O_2}) + 2.614 \times 10^{-9} \exp(-8.508 \times 10^{-20} N_{O_2})]$. (auth)

41655 ELECTRON DENSITIES BELOW 100 KILOMETERS AT MIDLATITUDES (L = 2.5 TO 4.0) DURING SOLAR MINIMUM AND MAXIMUM YEARS: PRELIMINARY MODEL CALCULATIONS. Manson, A. H. (Univ. of Saskatchewan, Saskatoon). Radio Sci.; 7: No. 1, 57-62(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

Electron-production rates due to photoionization, $q_s(\chi, h)$, and particle precipitation, $q_p(h)$, were calculated for the midlatitude ionosphere from 70 to 140 km for conditions typical of solar minimum and maximum years. A simple model in which E and D regions are defined by Lyman β, euv (30 to 120 A), Lyman α, and x rays (2 to 10 A) is used. An atmospheric model having annual variations for the major constituents and a seasonally constant profile of nitric oxide is also incorporated in the calculations. Electron-density profiles have been derived using recent estimates of α_{eff}. Results of calculations are shown for solar zenith angles $\chi = 37°$ and 72°, typical of noon values for summer and winter seasons. Fluxes of precipitated electrons typical of geomagnetic midlatitudes (L = 2.5 to 3.5) are used. For both solar minimum and maximum years, the seasonal variations in $q_t(h)$ and $N_t(h)$ differ significantly from those of a Chapman layer, partly because production rates from 80 to 100 km due to particle precipitation are from 25 to 90% of the total. One aspect of the "heavily ionized" winter lower ionosphere is discussed. Calculated diurnal variations in ionization for conditions typical of solar maximum years at higher latitudes (L = 3.5 to 4.0) also reveal irregular variations with χ due to the particle precipitation contribution. (auth)

41656 NIGHTGLOW EVIDENCE OF PRECIPITATING ENERGETIC ELECTRONS IN THE MIDLATITUDE NIGHTTIME D REGION. Potemra, T. A.; Zmuda, A. J. (Johns Hopkins Univ., Silver Spring, Md.). Radio Sci.; 7: No. 1, 63-6(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

The intensity range of precipitating electrons with E > 40 keV determined from a previous review of satellite and rocket data is used to compute the latitude variation of the 3914-Å and 4278-Å intensities of the first negative system of N_2^+. The range of computed airglow intensities encompasses the values observed at Saskatoon, Silver Spring, and Kitt Peak located at geomagnetic latitudes of 60°, 50°, and 40°, respectively. Therefore, these >40 keV electrons, which are a potentially significant source of ionization in the nighttime D region, also provide a sufficient energy input to the ionosphere to account for these nightglow observations. (auth)

41657 IONIZATION CONTRIBUTION BY COSMIC X RAYS. Mitra, A. P.; Ramanamurty, Y. V. (National Physical Lab., New Delhi). Radio Sci.; 7: No. 1, 67-72(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

The contribution of cosmic x rays in the production of ionization in the nighttime D region is discussed in the light of observed x-ray flux emissions from the various celestial x-ray sources and from the galactic background. The cumulative effect of several sources when they are in transit at close time intervals can amount to a sizable fraction of all nighttime sources, which consist principally of scattered Ly α and Ly β. Above 95 km, the Ly β contribution is generally far in excess of the production due to cosmic x rays, but, at and around 90 km, the relative importances of cosmic x rays and scattered Ly α depend on the variation of the scattered Ly α flux, its variations with time, the nighttime concentrations of nitric oxide, and on the variations in the flux from the sources. Since some of these are uncertain, exact contributions are difficult to establish, but a marginal ionospheric effect around 90 km levels from cosmic x-ray sources seems possible at low latitudes. (auth)

41658 POSITIVE ION CHEMISTRY OF THE D AND E REGIONS. Donahue, T. M. (Univ. of Pittsburgh). Radio Sci.; 7: No. 1, 73-80(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

A comparison of ion–molecule reaction rates implied by E- and F-region chemistry and measured in the laboratory shows, on the whole, good agreement except that the ionospheric analysis demands stronger temperature dependences. In the daytime D region, it is claimed that the reconciliation of positive ion densities with production rates and laboratory rate constants would best be achieved if (1) ionization of $O_2(^1\Delta_g)$ and hydration of O_4^+ in competition with the reduction of O_4^+ to O_2^+ by O were the dominant source of hydrates between 85 and 77 km, (2) ionization of NO by solar Lyman α followed by hydration was the dominant source of hydrates below 77 km, and (3) for some reason, Lyman α did not ionize NO effectively at pressures below those prevailing at 75 km. A discussion of large auroral NO densities will emphasize difficulties in accepting them but will offer no explanation for their observation. (auth)

41659 RESULTS OF CONCENTRATION AND MOBILITY MEASUREMENTS FOR POSITIVELY AND NEGATIVELY CHARGED PARTICLES TAKEN BETWEEN 85 AND 22 KM IN SOUNDING ROCKET EXPERIMENTS. Rose, G.; Widdel, H. U. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). Radio Sci.; 7: No. 1, 81-7(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

The results of two experiments designed to measure the concentration (and, in one case, the relevant mobilities) of charged particles of both signs in the mesosphere region are presented. In the mobility experiments two groups of positively charged particles were found in the height region 58 to 72 km. The heavy group was about four times less, the light group about eight times more mobile than the extrapolated mobility of light ions measured on the ground. The mobility of the negative particles was about equal to the mobility of the light group of positive carriers. It was therefore concluded that the negative ions and the "light" positive carriers were molecule ions, whereas the heavy, positively charged group belonged to heavier, aerosol particles. The second experiment, a modified-Langmuir probe arrangement, was designed to determine the critical height above which the probe current is predominantly caused by free electrons. This height was found to be around 62 or 63 km. In both experiments a considerable increase of ionization was found below 50 km, whereas two other flights with the modified Langmuir probe did not show this additional layer. It was found that both the mobility experiment and the Langmuir experiment were flown about half an hour after an SID, whereas the other two Langmuir experiments were flown under normal conditions. It is suspected that the observed additional ionization was generated in connection with the SID events by either wave or particle radiation. (auth)

41660 SUPERSONIC AND SUBSONIC MEASUREMENTS OF MESOSPHERIC IONIZATION. Hale, L. C. (Pennsylvania State Univ., University Park); Nickell, L. C.; Kennedy, B.; Powell, T. A. Radio Sci.; 7: No. 1, 89-91(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

An Arcas rocket–parachute system was used at night to compare supersonic and subsonic ionization measurements below 75 km. A hemispherical nose-tip probe was used on ascent and a parachute-borne blunt probe on descent to measure polar conductivities, which were due entirely to positive and negative ions. The velocity of the supersonic probe was ~Mach 2.5 at 50 km and 1.75 at 70 km; the blunt probe was subsonic below 71 km. Between 65 and 75 km the ratio of negative to positive conductivities (and thus of mobilities) determined by the blunt probe was about 1.2, and it approached 1 below this altitude range. The ratio obtained by the nose-tip probe varied from 1.5 at 75 km to 0.6 at 65 km, thus indicating a rapid variation of the effects of the shock wave on the sampled ions. The absolute values of positive conductivity measured subsonically and supersonically were essentially identical from 60 to 75 km, indicating that the sampled ions were unchanged by the shock. However, below 60 km the shock apparently "broke up" the positive ions, as indicated by higher measured conductivities. The negative ion conductivities for the supersonic case indicated that the sampling was badly disturbed by the shock. The negative ions were apparently lighter (higher mobility) than those sampled subsonically above 72 km and below 50 km. However, they appeared heavier (lower mobility) at the intervening altitudes. (auth)

41661 POSITIVE-ION COMPOSITION IN THE LOWER IONOSPHERE. Krankowsky, D.; Arnold, F.; Wieder, H.; Kissel, J.; Zaehringer, J. (Max- Planck-Institut fuer Kernphysik, Heidelberg). Radio Sci.; 7: No. 1, 93-8(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

The results of four positive-ion mass-spectrometer experiments in the lower ionosphere are reported. The data were obtained at high latitudes under different ionospheric conditions. The presentation is concentrated on the O_2^+, NO^+, and water-cluster ions. Possible effects of different primary-ion production and of low temperatures on the ion population are discussed in terms of current reaction schemes. (auth)

41662 POSITIVE ION MASS SPECTROMETER OBSERVATIONS IN THE E REGION. Johnson, C. Y. (Naval Research Lab., Washington, D. C.). Radio Sci.; 7: No. 1, 99-101(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

Positive-ion mass spectrometer observations of the auroral-zone ionosphere above Fort Churchill and the midlatitude ionosphere above White Sands are reviewed. The auroral-zone ionosphere, either day or night, resembles the midlatitude daytime ionosphere. Decay of the ionosphere at sunset and into the night is seen from measurements made above White Sands. The midlatitude nighttime ionosphere in the E region is sustained at an ion density of about 10^3 ions/cm^3 by resonantly scattered ionizing solar radiation. Sporadic-E events are seen as concentration of metallic atomic ions, primarily of Mg^+ and Fe^+. (auth)

41663 STUDY OF E-REGION ION CONCENTRATION AND COMPOSITION BY INCOHERENT SCATTER RADAR. Evans, J. V. (Massachusetts Inst. of Tech., Lexington); Oliver, W. L. Radio Sci.; 7: No. 1, 103-12(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

The incoherent scatter radar technique was used for studies of the E-region ion concentration and composition. A number of existing incoherent scatter radars are capable of securing profiles of ion concentration in the E region with a height resolution of 1 or 2 km by integrating the signals for several minutes. The advantage of these measurements is the ease with which a continuous time history may be secured. The height resolution is probably open to improvement by using coded pulses, but this remains to be attempted. The technique is of less value in studying the ion composition; and to date, only the relative abundance of atomic (O^+) to molecular (principally NO^+ and O_2^+) ions has been deduced from incoherent-scatter measurements. Even here it has usually been necessary to adopt a model for the ion temperature as a function of altitude. Nevertheless, these composition measurements clearly show a seasonal variation of the O/N_2 ratio in the thermosphere which is believed to be responsible for the seasonal anomaly in F-region density. Recently, the accuracy of the measurements and the data reduction procedures have been improved to the point where the relative ion abundance can be determined over the altitude interval 120 to 200 km, given only that this be a continuous smooth function. (auth)

41664 RECENT LABORATORY MEASUREMENTS OF D- AND E-REGION ION–NEUTRAL REACTIONS. Fehsenfeld, F. C.; Ferguson, E. E. (NOAA Environmental Research Labs., Boulder, Colo.). Radio Sci.; 7: No. 1, 113-15(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

Results are presented for recent measurements of reaction rates using the NOAA flowing afterglow systems. These include the $O_2^+-H_2O$ reaction sequence, the hydration of NO^+, and new measurements of charge exchange and ion–atom interchange for E-region ions. (auth)

41665 REACTIONS INVOLVING CLUSTER IONS. Niles, F. E.; Heimerl, J. M.; Keller, G. E.; Puckett, L. J. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Radio Sci.; 7: No. 1, 117-23(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

Rate constants for room-temperature reactions involving atmospheric cluster ions were measured using two laboratory facilities: (1) a stationary afterglow facility employing photoionization and separate mass analysis for ions and neutrals, and (2) a drift tube facility employing thermionic emission of alkali ions and mass analysis of ions. In the afterglow facility, the sequence of reactions initiated by NO^+ ions reacting in a gaseous mixture of nitric oxide and water vapor and terminated by $H_3O^+ \cdot 4H_2O$ was studied at 296°K with each rate constant measured independently. Likewise, the sequence of reactions initiated by NO^+ ions reacting in a gaseous mixture of nitric oxide and ammonia and terminated by $NH_4 \cdot 3NH_3$ was studied at 296°K. In the drift tube facility, the clustering of atmospheric gases to the alkali ions Li^+, Na^+, and K^+ was studied. From laboratory studies of the clustering of atmospheric gases to alkali ions, a map of the minimum values for initial clustering reaction rate constants and equilibrium constants was drawn. The importance of the formation of a weakly bound cluster ion followed by a switching reaction to form a strongly bound cluster ion to the ion chemistry of the D region was shown. (auth)

41666 LABORATORY MEASUREMENTS OF ION CHEMISTRY IN A SIMULATED DISTURBED IONOSPHERE. Hirsh, M. N.; Eisner, P. N. (Dewey Electronics Corp., Paramus, N. J.). Radio Sci.; 7: No. 1, 125-31(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

Experimental results are presented from a partial simulation of the disturbed nighttime ionosphere at 300°K. $N_2:O_2$ mixtures at pressures from 0.1 to 30 torr are contained in a 700-liter chamber and irradiated by a diffuse beam of megavolt electrons. In dry gas, only the ions O_2-, O_2^+, and NO^+ are seen with the mass spectrometer at the onset of irradiation. As the electron bombardment continues, these ions interact with beam-generated neutral species to produce a spectrum eventually dominated by NO^+, NO_2^-, and NO_3^-. From measurements of O_2^+ production and loss rates as a function of irradiation time, the dominant NO production mechanism is shown to be $O_2^+ + N_2 \rightarrow NO^+ + NO$ with a rate constant $\leq 1 \times 10^{-16}$ cm³/sec, followed by ionic recombination to neutralize the NO^+. The following thermal-energy two-body ionic recombination coefficients, in units of 10^{-8} cm³/sec, were made: $\alpha(NO^+, NO_3^-) = (3.4 \pm 1.2)$; $\alpha(NO^+, NO_2^-) = (17.5 \pm 6.0)$; and $\alpha(O_2^+, O_2^-) \leq (14 \pm 5)$. With water added to the gas, the sequence $H_3O^+(H_2O)_n$ ($n = 0, 1, 2, 3$) becomes important in the positive-ion spectrum. (auth)

41667 EFFECTIVE ELECTRON LOSS RATES IN THE LOWER D REGION DURING THE DECAY OF SOLAR X-RAY FLARE EVENTS. Montbriand, L. E.; Belrose, J. S. (Communications Research Centre, Ottawa). Radio Sci.; 7: No. 1, 133-42(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

The ionization changes that occur during solar x-ray (SXR) flares were used to study electron loss rates at low altitudes in the D region. The electron production from SXR radiation was calculated from fluxes obtained by SOLRAD 9, and the changes in the ionization densities were measured by the partial-reflection technique. Effective loss rates were determined at various heights during the SXR flare effect and for several sizes of flares at different times of the year. The rate values obtained were lower than those reported by Reid [1970], and are interpreted as resulting from a destruction of large water-cluster ions during the initial stages of the SRX flare effect. These cluster ions have fairly large effective loss rates, and their disappearance would result in a reduced effective loss rate. (auth)

41668 INFORMATION OF THE D- AND E-REGION ELECTRON DENSITY PROFILES. Thrane, E. V. (Norwegian Defence Research Establishment, Kjeller). Radio Sci.; 7: No. 1, 143-52 (Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

Available information on the D- and E-region electron-density profile is surveyed. The behavior of the E-layer peak in time and space is fairly well mapped from ionosonde measurements. Knowledge of the ionization distribution below the maximum of the E layer comes from a limited number of rocket flights through the lower ionosphere and from extended time series of observations by ground-based radio methods from a few stations. From such measurements a very sketchy and imperfect picture emerges of the electron-density profile in the quiet and disturbed lower ionosphere and its geographical, diurnal, seasonal, and sunspot-cycle variation. (auth)

41669 MEASUREMENTS OF D- AND E-REGION ELECTRON DENSITIES BY THE INCOHERENT SCATTER TECHNIQUE AT MILLSTONE HILL. Armistead, G. W.; Evans, J. V.; Reid, W. A. (Massachusetts Inst. of Tech., Lexington). Radio Sci.; 7: No. 1, 153-62(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

At Millstone Hill it is difficult to make incoherent scatter measurements of the electron density in the ionosphere at altitudes below 160 km because of the presence of interfering ground-clutter echoes. Modifications have been made to the zenith-pointing 220-foot antenna to reduce the energy radiated at low angles and, as a result, the ground-clutter echoes now do not normally exceed the dynamic range of the receiver. Accordingly, it is possible to filter the clutter echoes from the ionospheric echoes on the basis of their narrow spectrum. Electron densities have been measured in the E and D regions down to an altitude of 75 to 80 km. In the measurements made so far, a 3-km-height resolution has been employed and the results clearly indicate the presence of sporadic-E layers and other features regularly seen on rocket flights. Echoes appear to be obtained at altitudes below 80 km that are too strong to be caused by free electrons, and it may be that these echoes result from imperfect cancellation of clutter returns or from turbulent irregularities in the neutral atmosphere. (auth)

41670 DIURNAL AND SEASONAL VARIATION OF ELECTRON DENSITIES IN THE MIDLATITUDE D REGION UNDER QUIET CONDITIONS. Coyne, T. N. R.; Belrose, J. S. (Communications Research Centre, Ottawa). Radio Sci.; 7: No. 1, 163-74(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

Synoptic studies of the D-region electron densities using the differential-absorption partial-reflection experiment at 2.66 and 6.275 MHz are in progress at Ottawa (45°N, 76°W). The measurements are made from about one hour before sunrise to one hour after sunset throughout the winter and for 10 consecutive days each month during the other seasons. The methods employed to analyze data obtained over long periods are outlined and average electron densities showing diurnal behavior under quiet conditions are presented. Over the greater part of the day (i.e., for solar-zenith angles less than about 75°) the electron number densities show regular solar control with values increasing toward local noon. However, there is an asymmetry about local noon of up to 6° in solar-zenith angle, the morning electron densities being lower than those at the corresponding time in the afternoon. The diurnal changes for solar-zenith angles greater than 75° are more complicated. The formation over dawn of a C layer at heights below 75 km can be observed, and there is evidence that this layer decays after a solar-zenith angle of about 90°. This decay continues until arrested by photoionization processes. (auth)

41671 POSITIVE IONS AND THE WINTER ANOMALY. Mitchell, J. D. (Pennsylvania State Univ., University Park); Hale, L. C.; Olsen, R. O.; Randhawa, J.; Rubio, R. Radio Sci.; 7: No. 1, 175-9(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

A coordinated rocket program to study winter variability in D-region ionization was conducted at White Sands Missile Range, New Mexico, during the winter of 1970–1971. Parachute-borne blunt probes that measure positive-ion and electron conductivities were flown, in conjunction with other experiments, on January 22 and 26 and February 1, 1971. Both A1 and A3 radiowave absorption techniques were used to indicate anomalous winter days. The two rocket shots in January occurred on such days of high absorption. The first of these was one of quiet solar activity, whereas the second was preceded by a major solar proton event on January 24. The third flight occurred on a normal winter day. Unusual meteorological conditions preceded January 22, but not January 26 and February 1. Although the enhancement in electron densities was about the same on the two anomalous days (the radiowave absorption relating primarily to electron densities above 80 km and the blunt probe showing an enhancement of about 2 to 3 over the control day below 80 km), the positive-ion measurements showed that they were in fact quite different in character. The positive ions in the range 50 to 60 km on January 26 were almost precisely the same as those on the control day. This indicates that there was no change in the ion production or loss processes and implies that the enhanced electron density was due to a chemical change (but possibly related to the preceding solar event) in the attachment-detachment balance. By contrast, on January 22 the positive ions showed a factor of 1.5 or more increase in the altitude range 50 to 60 km. The fact that this enhancement occurred at an altitude where the ionization is cosmic ray rather than solar controlled indicates that the enhancement was due to a decrease in the loss rate rather than an increase in production. It is concluded that two days of "anomalous" winter absorption of very different character, one possibly related to a solar disturbance, and one probably entirely induced by meteorological effects, have been observed. The former day was probably characterized by inhibition of the formation of negative ions due to increased detachment and the latter by decreased ionization loss rate. (auth)

41672 RESULTS OF AN EXPERIMENTAL INVESTIGATION OF CORRELATIONS BETWEEN D-REGION NEUTRAL GAS WINDS, DENSITY CHANGES, AND SHORT-WAVE ABSORPTION. Rose, G. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.); Widdel, H. U.; Azcarraga, A.; Sanchez, L. Radio Sci.; 7: No. 1, 181-91 (Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

Between December 1969 and March 1970, a total of 26 Skua-2 rockets were successfully launched close to local noon at Arenosillo, Spain. From the use of an ultralight chaff, the winds and chaff fall rates were determined at heights between 75 and 95 km. At the same time, A3 absorption measurements were carried out on 2.83 MHz between Aranjuez (Madrid) and Arenosillo. From the wind and fall-rate measurements, a quantity has been derived for each kilometer height range, being roughly proportional to the air mass flow, that is wind vector over fall rate at the corresponding height levels. These flow vectors, which were obtained on different days at the different height levels, have been correlated with the noon absorption values $L \sim \int N \cdot v \cdot dh$ taken from the short-wave propagation path between Arenosillo and Aranjuez. A significant, but not very high, correlation was found between the mass flow at 90 to 93 km and the absorption L, which increased with increasing flow from the NNE. At 85 km, L increased with increasing flow from the SSW. For the other heights between 75 and 95 km, a significant correlation could not be found, although there is some indication of a relationship at 77 km. (auth)

41673 STRATOSPHERIC–IONOSPHERIC INTERACTION DURING THE MOVEMENT OF A PLANETARY WAVE IN JANUARY 1967. Williams, Ben H.; Olsen, Robert O.; Kays, Marvin D. (Army Electronics Command, White Sands Missile Range, N. Mex.). Radio Sci.; 7: No. 1, 193-213(Jan 1972).

From COSPAR symposium on D- and E-region ion chemistry; Urbana, IL. (6 Jul 1971). See CONF-710727.

Examination of meteorological synoptic analyses in the stratosphere and lower mesosphere and f_{min} values observed over North America reveals a significant correlation between the passage of a deep planetary wave and increased electron densities in the lower ionosphere. As evidence of this correlation, a series of synoptic analyses concentrated in the upper stratosphere, along with longitudinal cross section of zonal winds and temperatures, and profiles of f_{min} are illustrated. Correlation coefficients were calculated between mean daytime values of f_{min} and the zonal, meridional, and vertical components of the wind at 40 and 50 km. These calculations show, in general, that the correlation increases with altitude, decreases with an increase in latitude, and that the zonal wind in midlatitudes exhibits the highest correlation. Correlation coefficients between f_{min} and planetary magnetic indices, solar sunspot number, and solar flux would point to exclusion of extraterrestrial parameters as a source of the observed electron increase. (auth)

Effects of Nuclear Detonations

41674 LIGHTNING INDUCED BY THERMONUCLEAR DETONATIONS. Uman, M. A. (Westinghouse Research Labs., Pittsburgh); Seacord, D. F.; Price, G. H.; Pierce, E. T. J. Geophys. Res.; 77: No. 9, 1591-6(20 Mar 1972).

The lightning flashes induced by a thermonuclear detonation at Eniwetok Atoll in the Pacific in 1952 are described. The five discharges were upward-propagating and were apparently initiated from instrumentation stations slightly above sea level. The likely mechanism for the necessary charge and electric-field generation (Compton electrons produced by gamma rays from the detonation) is explored quantitatively. The electric-field intensity calculated 3×10^4 V/m is near the value needed to initiate lightning from surface projections. The charge estimated to be available, however, appears to be insufficient to account for the observed lightning. Scattered trade-wind cumulus clouds and spray electrification from the salt water are considered and rejected as charge sources. (auth)

41675 ATTENUATION OF BLAST WAVES BY THE ATMOSPHERE. Reed, Jack W. (Sandia Labs., Albuquerque, N. Mex.). J. Geophys. Res.; 77: No. 9, 1616-22(20 Mar 1972).

Acoustic attenuation theory with coefficients obtained by experiment is used to calculate losses from long-range propagation along various paths in a standard atmosphere. Frequency dependence of attenuation is incorporated into Fourier series approximations of positive phase waves from explosions to obtain net attenuations in terms of explosion yield and burst altitude. For some applications this incorporation improves on estimations from assumption of a single frequency of input. Attenuation results are presented for small 0.45-kg grenades burst at 30- to 90-km altitudes and for ton and kiloton explosives burst near the ground with waves propagated to 50-km altitudes and back to the ground near 200-km ranges. (auth)

41676 AIRBLAST OVERPRESSURE DECAY AT LONG RANGES. Reed, Jack W. (Sandia Labs., Albuquerque, N. Mex.). J. Geophys Res.; 77: No. 9, 1623-9(20 Mar 1972).

An empirical model is presented for explosion wave propagation, which demonstrates that pressure amplitude is inversely proportional to distance raised to the 1.2 power. This model resulted from recordings of vertical propagations, essentially unrefracted by the horizontally stratified atmosphere, and by comparison of amplitudes from different yields after nearly simultaneous propagation along more complex atmospheric paths. Recent NASA rocket grenade experiments provide basis for extending the scaled range of applicability to 8000 km from a 1-kt nuclear explosion. (auth)

Particle Kinetics and Trapping

Refer also to abstract 41651.

41677 DIRECT COMPUTATION OF THE MAGNETIC SHELL PARAMETER. Kluge, G. (ESOC, Darmstadt, Ger.). Comput. Phys. Commun.; 3: No. 1, 31-5(Jan-Feb 1972).

The magnetic coordinates B and L are adiabatic invariants of the motion of charged particles trapped in the magnetic field of the Earth, and are convenient for correlating measured particle fluxes. Execution speed and storage economy are important aspects of a program computing B and L. The solution method given involves the perturbation approach for the integration of the differential equations for the field lines. A general description is given of the computer program SHELL. The programs were run on an IBM 360-65 and compiled by FORTRAN (H) with OPT = 2 specified. The execution speed of the field routine depends strongly on the efficient compilation of DO-loops. (J.C.W.)

41678 NUMERICAL FITS FOR THE GEOMAGNETIC SHELL PARAMETER. Kluge, G.; Lenhart, K. G. (ESOC, Darmstadt, Ger.). Comput. Phys. Commun.; 3: No. 1, 36-41(Jan-Feb 1972).

The physical problem of the numerical fit for the geomagnetic shell parameter is the same as for the direct computation of the magnetic shell parameter where the magnetic coordinates B and L are adiabatic invariants of the motion of charged particles trapped in the magnetic field of the Earth and used conveniently for correlating measured particle fluxes. The method of solution involves the representation of the shell parameter by Fourier series and interpolation. Several hundred parameters are fitted to data obtained from direct computation. The rms error of the fit is about 0.05% and the typical running time to compute B and L is 12 msec. The direct computation time is lengthy. The numerical approximation used in the program INTEL is sufficiently accurate to eliminate the necessity of direct computation in most applications. (J.C.W.)

41679 STATE OF THE GEOMAGNETIC FIELD AND ITS REVERSALS. Levy, Eugene H. (Univ. of Maryland, College Park). Astrophys. J.; 175: No. 2, 573-81(15 Jul 1972).

Stationary solutions of the kinematic-dynamo equations are discussed when the fluid velocity consists of a spherical shell of nonuniform rotation and two or three pairs of rings of cyclonic convective cells. In addition the reverse toroidal magnetic flux produced by these dynamo fields is discussed in terms of its relevance to the phenomenon of geomagnetic reversal. It is estimated that some stationary dipole modes are unstable to a change in sign by fluctuations of 20 or 30% in the distribution of cells of cyclonic convection. (auth)

Solar Wind and Cosmic Ray Interactions

Refer also to abstracts 41652 and 41657.

41680 METHODS FOR DIRECT MEASUREMENT OF THE PLASMA POTENTIAL. Andersen, S. A.; Christoffersen, G. B.; Jensen, V. O.; Michelsen, P. Plasma Phys.; 14: No. 2, 202-4(Feb 1972).

A simple experimental technique is reported which can be used for the determination of the plasma potential in streaming plasmas. It is suggested that the technique might be useful in satellite measurement of the ion energy distribution function in the solar wind. (UK)

41681 NUMERICAL CALCULATION OF THE LUNAR WAKE IN A MAGNETOHYDRODYNAMIC MODEL. Beers, Brian Lee (Rice Univ., Houston, Tex.). Phys. Fluids; 15: No. 8, 1450-6 (Aug 1972).

Following previous interpretation, a model is developed which has the solar wind flowing directly into the lunar surface and the magnetic field passing unimpeded through the moon. The collapse of the plasma void behind the moon is calculated numerically using the equations of magnetohydrodynamics. The model is three-dimensional, allowing complete calculations to be made without special restrictions on the magnetic field direction. A cursory quantitative comparison with data shows agreement to be satisfactory. The calculations indicate that the rate of collapse of the void does not depend strongly on the solar wind–magnetic field angle. The penumbral decrease depends very strongly on both the solar wind–magnetic field angle and the angle of passage through the wake. (auth)

PHYSICS (ATOMIC AND MOLECULAR)

41682 MOLECULAR SPECTROSCOPY: MODERN RESEARCH. Rao, K. Narahari; Mathews, C. Weldon (eds.). New York; Academic Press, Inc. (1972). 433p. $25.00.

Current advances in several phases of research in high-resolution molecular spectroscopy are reviewed in chapters by different authors on the following subjects: hyperfine structure in the electronic spectrum of I_2; microwave spectroscopy; rotational levels of free radicals; rotational energy transfer from microwave line broadening; rotational spectra of molecules with two internal degrees of freedom; interstellar molecules and the interstellar medium; high-resolution infrared spectroscopy of planetary atmospheres; vibration–rotation structure in asymmetric- and symmetric-top molecules; molecular laser emissions in the infrared; electronic spectroscopy of polyatomic molecules; the O_2^+ $b^4\Sigma_g^- - a^4\Pi_u$ band system; a chrestomathy of energy transfer research on iodine; nuclear hyperfine structure in the electronic spectra of diatomic molecules; infrared and ultraviolet spectroscopic studies of free radicals and molecular ions isolated in inert solid matrices; the competition among biprotonic photoautomerism, excimer formation, and proton tunneling in DNA base-pairs; Fourier spectroscopy; grille spectrometers; large plane gratings for high-resolution infrared spectrographs; and tables of standard data. A list of references follows each chapter. (A.G.W.)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 41521 and 41703.

41683 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 7, NO. 4, 1972. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 48p.

The listing includes 135 references on such topics as atomic collisions, interactions of ions and electrons with surfaces, surface properties, sorption and desorption, and radiation effects on surfaces. (A.G.W.)

41684 RELATIVISTIC EFFECTS IN Au L X-RAY PRODUCTION BY 0.5- TO 3.0-MeV PROTONS. Bissinger, G. A. (Univ. of North Carolina, Chapel Hill); Baskin, A. B.; Choi, B.-H.; (and others). Phys. Rev., A; 6: No. 2, 545-8(Aug 1972).

Intensities and energies of gold $L\alpha$, $L\beta$, and $L\gamma$ composite x-ray peaks were measured with a Si(Li) detector as a function of proton bombarding energies from 0.5 to 3.0 MeV. The ratios of $L\alpha/L\beta$ and $L\alpha/L\gamma$ peaks reach a maximum value at $E_p \approx 1$ MeV. An upward shift in the energy of the $L\gamma$ peak of ≈ 100 eV was observed at $E_p = 0.5$ MeV. Both effects (shifts and ratios) are due, at least in part, to the energy dependence of the L-subshell hole-production cross sections. The experimental results for the intensity ratios are in better agreement with theory if relativistic L-shell wave functions are used in the plane-wave Born-approximation calculations for L-subshell hole production. (auth)

41685 FIZIKA I TEKHNIKA PLAZMENNYKH ISTOCHNIKOV IONOV. (Physics and Technology of Plasma Ion Sources). Gabovich, M. D. Moscow; Atomizdat (1972). 304p.

The basic parameters and properties of plasma ion sources are elucidated in this monograph as a phenomenon which is finding wide application in fields of science and technology. Plasma sources of atomic and molecular ions of hydrogen, multicharged ions, negative ions, and refractory metal ions are discussed. Equipment for generating ion beams, the oscillatory properties of a plasma, their influence on plasma ion sources, and neutralized ion beams are topics which are treated in individual chapters. Many line drawings of the mechanical devices are presented. (648 references) (K.S.W.)

41686 EXTRACTION OF HIGH CURRENT ION BEAMS WITH LAMINATED FLOW. Kanaya, K. (Kogakuin Univ., Tokyo); Koga, K.; Toki, K. J. Phys., E (London); 5: No. 7, 641-8(Jul 1972).

The basic concepts underlying the extraction of a high current ion beam with low convergence from a duoplasmatron are discussed ion optically with the aid of a ray tracing method. The modified extraction system is composed of two cylindrical electrodes, one the anode and the other the extractor, and it is controlled by the application of a combined magnetic field and electrical field to this bipotential lens. The anode which is composed of a cone-shaped orifice and a cylindrical expansion electrode with a concave cap allows the satisfactory expansion of the high density plasma and allows extraction of laminated flow from the concave plasma boundary. Currents of 20 mA at 20 keV are obtained. The current density is measured by the erosion of a fine mesh and the machining of stainless steel inserted into the beam path. It was shown that a high current ion beam with a laminated flow satisfying the space charge limiting current and with a highest brightness of 10^{11} A m^{-2} sterad^{-1} can be extracted and is very useful for ion beam processing applications. (auth)

41687 SCATTERING OF THERMAL HELIUM ATOMS FROM A MERCURY FILM DEPOSITED ON A LITHIUM FLUORIDE SUBSTRATE. Mason, B. F.; Williams, Brian R. (National Research Council of Canada, Ottawa). J. Chem. Phys.; 57: No. 2, 872-84 (15 Jul 1972).

Films of mercury were deposited on a lithium fluoride substrate in an attempt to observe diffraction phenomena in the scattering pattern of helium atoms. No diffraction effects were observed. A large variation of the elastic (00) peak with surface temperature was observed, and an attempt was made to use this information in discussing the Debye–Waller effect. A large component of inelastic scattering was observed and reasons are presented to account for its wide distribution in space. Also studied was the scattering behavior of helium atoms from partially continuous mercury films at various stages in the nucleation process. (auth)

41688 ALPHA- AND PROTON-INDUCED X-RAY DEEXCITATION OF TITANIUM. Richard, Patrick; Senglaub, Mike; Johnston, Brant; Moore, C. Fred (Univ. of Texas, Austin). Appl. Phys. Lett.; 21: No. 1, 13-14(1 Jul 1972).

Measurements of $K\alpha$ and $K\beta$ x rays induced by proton and α-particle beams from an electrostatic accelerator show a divergence from the normal x-ray spectra as the nuclear charge increases. These measurements are consistent with the explanation that the ion excitation produces multiple inner-shell electron vacancies, which in turn cause electronic-shell energy shifts. The intensity of these shifted lines is a measure of the amount of multiple inner-shell ionization. (auth)

41689 TRANSMISSION SPUTTERING AND RECOIL IMPLANTATION FROM THIN METAL FILMS UNDER ION BOMBARDMENT. Perkins, J. G.; Stroud, P. T. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Instrum. Methods; 102: No. 1, 109-15(1972).

Values of the transmission sputtering yield of aluminum when bombarded with 30- to 100-keV Ar^+ ions were obtained. Also values of recoil implantation yield for Ar^+ on aluminum were measured with aluminum films deposited onto pure silica and polyethylene. The results are compared with the sputtering theory of Sigmund and good agreement was achieved. Estimates of the range of recoil-implanted atoms are made using electrical measurement techniques, and it is concluded that the range is too small for the method to be useful for conventional semiconductor doping but great enough for surface and thin film doping. (auth)

41690 SECONDARY EMISSION OF Li_n^+ MOLECULAR IONS $1 \leq n \leq 9$ FROM A Li TARGET. Joyes, Pierre (Univ., Paris); Leleyter, Mireille. Compt. Rend., Ser. B; 274: No. 11, 751-3 (13 Mar 1972). (In French).

Variations in the relative intensity of the secondary emission of M_n^+ molecular ions from a metallic target, with the parity of n occur for Cu and Ag (elements with an outer s electron). The phenomenon was interpreted by calculating the physical characteristics of these clusters. The same behavior was experimentally confirmed for Li($1s^2$ $2s$) for $n > 3$. (auth)

Atomic and Molecular Properties

Refer also to abstracts 41682, 41705, and 41731.

41691 SET OF EMPIRICAL TOTAL ATOMIC BINDING ENERGIES B_Z, AND THEIR DERIVATIVES $\partial B_Z/\partial Z$, FOR ALL $Z \leq 18$. Rubinson, William (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., A; 6: No. 2, 701-9(Aug 1972).

A method is described whereby it is possible to make accurate empirical estimates of ionization potentials that are missing in Moore's "atomic energy levels," and so obtain empirical total atomic binding energies B_Z with estimated uncertainties less than

0.005%, for all $Z \leq 18$. These B_Z values are used to compute values of $\partial B_Z/\partial Z$, with quite small assigned uncertainties (~0.15% for $Z \geq 12$). The relativistic Dirac–Hartree–Fock calculations of Mann reproduce these empirical values to within amounts a few times the uncertainties. (auth)

41692 TEST OF INVARIANCE OF THE IONIZATION-ENERGY THRESHOLD VALUE WITH EJECTION ENERGY. Freedman, M. S.; Porter, F. T. (Argonne National Lab., Ill.). Phys. Rev., A; 6: No. 2, 659-66(Aug 1972).

High-energy inner-shell ionization processes generate a spectrum of lower-energy shake-up lines and shake-off band satellites of a main electron energy peak, corresponding to excitations and multiple ionizations of the daughter ion. Such satellite final states give reduced screening for the ejected inner electron, and consequently the observed rise in binding energy. The conventional view that the effective binding energy corresponding to the main peak is independent of transition energy in such fast ionizations was verified experimentally; four transitions in $^{241}_{95}$Am, one only 7 keV above the K binding energy of 125 keV, gave (L_1–K) internal-conversion electron energy differences of ~101 keV, constant within 5 eV, over an electron energy range from 7 keV (v/c = 0.14, nearly adiabatic) to 450 keV (v/c = 0.85). This implied invariance of the K mainline binding energy within 5 eV is contrasted to a calculated rearrangement energy value of 88 eV from a Dirac–Hartree–Fock (DHF) "frozen-orbital" eigenvalue minus the full atom–ion DHF "adiabatic" energy difference. Further, the main peak binding energy should be the threshold adiabatic value; comparison of our (L_2–K) electron energy difference, 102.031 ± 0.005 keV, with the $K\alpha_2$ x-ray energy, 102.033 ± 0.010 keV, verifies this to 12 eV. The displacement of the centroid of the satellite spectrum from the main peak, i.e., the mean increase in binding energy averaged over this spectrum as the transition energy increases infinitely above threshold, should equal the rearrangement energy of the ion. Based on β-decay shake-off intensity predictions for all shells of Carlson, Nestor, Tucker, and Malik and on these experimental results for K and L shells at lower Z, a centroid shift of 89 ± 10 eV is calculated for Am. (auth)

41693 EFFECT OF CORE POLARIZATION UPON THE f–f INTERACTIONS OF RARE-EARTH AND ACTINIDE IONS. Morrison, John C. (Argonne National Lab., Ill.). Phys. Rev., A; 6: No. 2, 643-50(Aug 1972).

Corrections to the interaction integrals of valence electrons, which are due to the interaction of configurations for which a single electron is excited from the core, are calculated using a perturbed-function approach. Numerical results are given for Pr^{3+}, Dy^{2+}, Er^{3+}, and Pu^{3+}. (auth)

41694 RESONANCE-NARROWED-LAMB-SHIFT MEASUREMENT IN HYDROGEN, n = 3. Fabjan, C. W.; Pipkin, F. M. (Harvard Univ., Cambridge, Mass.). Phys. Rev., A; 6: No. 2, 556-70(Aug 1972).

A new measurement of the Lamb shift in the n = 3 state of atomic hydrogen is reported. The experiment was performed in zero magnetic field with a fast hydrogen beam. The radiofrequency spectroscopy measurements were made with both a single oscillating field and two separated oscillating fields. The final result for the Lamb shift was $S(H, n = 3) = (314.819 \pm 0.048)$ MHz. In a further experiment, the separated-oscillating-field technique was used to narrow the resonance so that the linewidth was less than the natural linewidth. (auth)

41695 OBSERVABILITY OF HYPERFINE STRUCTURE AND LAMB AND NUCLEAR-VOLUME SHIFTS IN 1snl–1snl' TRANSITIONS OF HELIUM-LIKE IONS. Kastner, Sidney O. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., A; 6: No. 2, 570-3(Aug 1972).

The hyperfine-structure widths of 1snl–1snl' transitions in helium-like ions are estimated for n = 2, 3 and Z up to 30. Relevant parameters such as spin–orbit and electrostatic parameters are also calculated on the basis of screened hydrogenic functions. It is found that the hyperfine-structure widths are greater than 10 Å at accessible visible wavelengths in some cases. Also, absolute wavelength shifts due to Lamb and nuclear-volume effects are of the order of several angstroms. (auth)

41696 ENERGIES AND LIFETIMES OF DOUBLY EXCITED STATES IN He I. Berry, H. G.; Desesquelles, J.; Dufay, M. (Univ. Lyon, Villeurbanne, France). Phys. Rev., A; 6: No. 2, 600-6(Aug 1972).

The beam–foil technique was used to observe radiative transitions between doubly excited states of He I. From previous calculations, many of these transitions were classified. Some of the lifetimes of the upper states were obtained from decay-time measurements. There is good agreement between theory and experiment for both wavelengths and radiative lifetimes. A transition between doubly excited states in Li II was also observed, and experiment and theory are compared for higher members of the He I isoelectronic sequence. (auth)

41697 UPPER LIMITS OF ROTATIONAL STATES OF H_2, H_2^+, CH, AND CH^+. Sundaram, S. (Univ. of Illinois, Chicago). J. Quant. Spectrosc. Radiative Transfer; 12: No. 7, 1147-50 (Jul 1972).

Theoretical considerations previously reported (Sundaram 1972) were used to obtain the upper limits of rotational states of the systems of H_2, H_2^+, CH, and CH^+. The potential-energy functions due to Morse and Hulburt–Hirschfelder were considered for this study. In general, the limiting values for the Morse function are higher than for the Hulburt–Hirschfelder potential in the systems discussed. (auth)

41698 LOW-LYING RESONANCE IN THE SPECTRUM OF H^-. II. THE 2^1P STATE. Van Rensbergen, W. (Vrije Univ., Brussels). J. Quant. Spectrosc. Radiative Transfer; 12: No. 7, 1105-13(Jul 1972).

The wave function containing 20 parameters and the corresponding energy of the 2^1P state of H^- were calculated. As is well known this state lies in the H^- continuum. The inclusion of this state in the expansion of the continuum wave function can drastically influence the cross section of an electron scattered by a hydrogen atom in the energy region involved. This bound pseudostate will, in any case, influence the continuum absorption coefficient, but it may be insufficient to guarantee a peak in this absorption coefficient or in any e^-–H scattering experiment. Anyway, a new 2^1P virtual state of H^- is obtained with an energy of approximately −0.92 Ry. The exact position of the resonance needed to account for the occurrence of the diffuse interstellar line at 6180 Å is −0.9079 Ry. Since this resonance must lie very near the position of the bound state, the results support the identification of the broad feature at 6180 Å as a transition in H^-. (auth)

41699 EXPERIMENTAL WORK OF PIXTON AND FOWLES. Gudzenko, L. I.; Zemtsov, Yu. K.; Yakovlenko, S. I. Kratk. Soobshch. Fiz.; No. 12, 3-7(Dec 1971). (In Russian).

The transition $3^3S_1 \rightarrow 2^3P_{1,2}$ (λ = 7,065 Å) for a He atom had previously been reported by R. M. Pixton and G. R. Fowles (Phys. Lett., 29A: 654(1969). An inversion had been observed in the afterglow of a pulsed high-voltage discharge through a H_2–He mixture in which H^- and He^+ are present. The mechanism proposed is discussed and an analogy is made to an interaction between H^- and Na^+. (K.S.W.)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 41703, 41728, 41868, 41907, 42005, and 42468.

41700 POSITRON VERTEX RENORMALIZATION OF THE EFFECTIVE ELECTRON–POSITRON INTERACTION. Baldo, M.; Pucci, R. (Univ., Catania, Italy. INFN, Catania, Italy). Phys. Lett.; 40A: No. 1, 86-8(19 Jun 1972).

An explicit expression for the positron vertex function in an electron liquid is derived. It is shown that positron vertex corrections to the effective electron–positron interaction are relevant and can be of help in explaining some discrepancies between theory and experiments in positron annihilation. (auth)

41701 ANALYSIS OF MUONIC X RAYS IN TERMS OF EQUIVALENT RADIUS. Kim, Y. N.; Khan, M. (Texas Tech Univ., Lubbock). Phys. Lett.; 40B: No. 2, 217-19(26 Jun 1972).

The analysis of muonic ^{208}Pb atom transition energies in terms of the equivalent radius shows that it is impossible to obtain a precision fit starting from a two-parameter Fermi-type nuclear charge distribution. The introduction of the corrections formally equivalent to the muon finite size effect improves the fit of the transition energies as well as the simultaneous fit of muonic x-ray and electron scattering data. (auth)

Collision Phenomena

Refer also to abstracts 41683, 42228, and 42366.

41702 (IAE-2107) DIFFUSION THEORY OF THE EXCITED ATOMS AND MOLECULES. Novikov, V. M. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 28p. (In Russian). Dep. NTIS (U. S. Sales Only).

Differential scattering cross sections of resonance excited atoms (molecules) were calculated. The contribution of elastic and inelastic processes to the scattering was investigated. It is shown that the diffusion rate of resonance excited atoms may be several orders less than that of atoms in the ground state. (auth)

41703 (ORNL-AMPIC-14) BIBLIOGRAPHY OF ATOMIC AND MOLECULAR PROCESSES FOR JANUARY–DECEMBER 1970. (Oak Ridge National Lab., Tenn.). Jun 1972. 60p. Dep. NTIS.

Literature related to atomic and molecular collision research is presented in this annotated bibliography. Bibliographical sources consisted of sixty-three scientific journals and three abstracting journals. References are cataloged under ten major categories with appropriate subcategories. For each entry the following information is indicated: the reactants studied, the type research (experimental or theoretical), the energy range, the author(s), and journal or book reference. (auth)

41704 (SC-RR-710893) ELECTRON EXCITATION OF NITROGEN FLUORESCENCE. Schelby, Frederick (Sandia Labs., Albuquerque, N. Mex.). Jun 1972. 50p. Dep. NTIS.

Two nitrogen rotational–vibrational band systems, which are easily excited by electron impact, were investigated because of their applicability to gas-flow diagnostics. For the first negative system a new noniterative method for computing the Muntz temperature is derived. It is shown that $T_R - T_{RM} = 5.8°K$, where T_R is the rotational temperature obtained upon the assumption that $\Delta K = 0$ for excitation and T_{RM} is the Muntz ($\Delta K = \pm 1$) rotational temperature. To give improved low-temperature results and to lessen the dependence of temperature upon density, the effects of secondary electrons were included. The N_2 second positive system, characterized by a useful linearity in its emission-intensity–gas-density curve, is shown to possess an extremely strong rotational temperature dependence upon density. Three possible excitation models, $\Delta K = 0$, $\Delta K = \pm 1$, and $\Delta K = \pm 1, \pm 2$, were found to be equally ineffective in correcting this dependence. Overpopulation of the higher rotational levels evident in both band systems is postulated to be due to excitation of the higher vibrational levels by the electrons. (auth)

41705 SINGLET–TRIPLET MIXING IN THE n = 3 STATES OF HELIUM. Krause, Daniel Jr.; Soltysik, Edward A. (Univ. of Massachusetts, Amherst). Phys. Rev., A; 6: No. 2, 694-701(Aug 1972).

The energy-independent ratio of the proton apparent-excitation cross sections between corresponding triplet and singlet states of helium for the n = 3 levels was measured. In the Russell–Saunders description of the states of helium, proton excitation of triplet states is forbidden; i.e., $\Delta S = 1$ transitions are not allowed (Wigner spin rule). However, the spin–orbit interaction for the two electrons in helium mixes the spin states. Thus, there is a small singlet component in the triplet-state wave function. The square of the small singlet–triplet mixing parameter $\gamma(3^3X)$ is equal to the ratio of the proton excitation cross sections to corresponding triplet and singlet states, i.e., $\gamma^2(3^3X) = \sigma_p(3^3X)/\sigma_p(3^1X)$. The symbol X refers to the orbital angular momentum states S, P, or D. If the ratio of the proton apparent-excitation cross sections $Q_p(3^3X)/Q_p(3^1X)$ is designated by $\beta^2(3^3X)$, then $\beta^2(3^3X) = \gamma^2(3^3X)$ + (cascade contributions). The results for $\beta^2(3^3X)$ for the n = 3 states of helium are as follows: $\beta^2(3^3S) = 0 \pm 0.0002$, $\beta^2(3^3P) = 0.0028 \pm 0.0007$, and $\beta^2(3^3D) = 0.06 \pm 0.014$. (auth)

41706 STUDIES OF THE POTENTIAL-CURVE-CROSSING PROBLEM. II. GENERAL THEORY AND A MODEL FOR CLOSE CROSSINGS. Delos, John B. (Univ. of Alberta, Edmonton. Massachusetts Inst. of Tech., Cambridge); Thorson, Walter R. Phys. Rev., A; 6: No. 2, 728-45(Aug 1972).

A unified formal treatment of the two-state potential-curve-crossing problem in atomic collision theory is presented, and the case of close crossings is analyzed in detail. A complete solution for this case, including necessary computations, is given using a suitable generalization of the linear model originally suggested by Landau, Zener, and Stueckelberg. This solution is based upon a hierarchy of approximations concerned with (i) choice of a discrete basis set for electronic coordinates, (ii) semiclassical treatment of the nuclear motion, (iii) an appropriate model for the two-state electronic Hamiltonian, and (iv) a complete solution to that model. (auth)

41707 ABSOLUTE DETECTION AND COLLISIONAL DESTRUCTION OF 2.5-keV METASTABLE HYDROGEN ATOMS PRODUCED BY A CHARGE-EXCHANGE PROCESS IN CESIUM VAPOR. Spiess, G.; Valance, A.; Pradel, P. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Rev., A; 6: No. 2, 746-55(Aug 1972).

A near-resonant charge-exchange process between incident protons and a cesium vapor target was studied. The cross section σ_{+0} for the production of all the neutral states of hydrogen decreases slightly with increasing energy. It varies from $(10 \pm 3) \times 10^{-15}$ cm^2 at 0.5 keV to $(6.4 \pm 1.6) \times 10^{-15}$ cm^2 at 2.5 keV. The cross section σ_{+m} for the production of the $2S_{1/2}$ metastable state of hydrogen is $(1.7 \pm 0.6) \times 10^{-15}$ cm^2 at 2.4 keV. The percentage of metastable atoms in the outgoing neutral beam is found to be 0.27 ± 0.08 for cesium target thickness less than 10^{13} atoms/cm^2. The outgoing fraction of $H(2S_{1/2})$ atoms reaches a maximum equal to 0.13 for a cesium thickness of 1.2×10^{14} atoms/cm^2. The collisonal quenching processes studied are the electron loss of $H(2S_{1/2})$ on the noble gases, H_2, N_2, and HI at 2.5 keV and the electron attachment of $H(2S_{1/2})$ on N_2 at the same energy. The electron-loss cross sections σ_{m+}, in units of 10^{-16} cm^2, and known with a 35% uncertainty, are 4.1 for He, 2.7 for Ne, 2.9 for Ar, 2.7 for Kr, 6 for Xe, 3.4 for H_2, and 5 for N_2. The cross section σ_{m+} is always greater than σ_{g+}, the electron-loss cross section for the ground state of hydrogen. The maximum ratio 9.7 of these two cross sections is obtained with the halogen compound target HI, which is an interesting gas to selectively ionize $H(2S_{1/2})$ in a beam containing the two species $H(2S_{1/2})$ and $H(1S_{1/2})$. A comparison of the data is made with theoretical predictions using an impulse approximation. Attachment cross sections of $H(2S_{1/2})$ and $H(1S_{1/2})$ have been measured on N_2 at 2.5 keV. It was found that $\sigma_{m-} = (1.2 \pm 0.4) \times 10^{-16}$ cm^2 and $\sigma_{g-} = (9.7 \pm 2) \times 10^{-18}$ cm^2. (auth)

41708 SEMICLASSICAL THEORY OF INELASTIC COLLISIONS. II. MOMENTUM-SPACE FORMULATION. Delos, John B.; Thorson, Walter R. (Univ. of Alberta, Edmonton). Phys. Rev., A; 6: No. 2, 720-7(Aug 1972).

The time-dependent equations of the classical picture of inelastic collisions (classical-trajectory equations) are derived using the momentum-space semiclassical approximation. Thereby it is shown that the classical-trajectory equations remain valid in the vicinity of classical turning points provided that (a) the momentum-space semiclassical approximation is valid, (b) the trajectories for elastic scattering in the various internal states differ only slightly, and (c) the slopes of the elastic scattering potentials have the same sign. A brief review of the existing derivations of the classical-trajectory equations is given, and the general conditions for their validity are discussed. (auth)

41709 SEMICLASSICAL THEORY OF INELASTIC COLLISIONS. I. CLASSICAL PICTURE AND SEMICLASSICAL FORMULATION. Delos, John B.; Thorson, Walter R.; Knudson, Stephen K. (Univ. of Alberta, Edmonton). Phys. Rev., A; 6: No. 2, 709-20(Aug 1972).

This series of papers is concerned with the derivation of the equations of the classical picture of atomic collisions, $i\hbar\, d/dt\, d_i(t) = \Sigma_j\, h_{ij}(t) d_j(t)$, which describe the "time" dependence of electronic-quantum-state amplitudes as the nuclei move along a classical trajectory. These equations are derived in two ways. In the first formulation, which coincides with the intuitive classical picture of the collision, the nuclear part of the wave function is treated as a superposition of narrow wave packets, each traveling along a classical trajectory. In the second formulation, a semiclassical approach is used. The validity and meaning of the two formulations are discussed and compared. (auth)

41710 VARIATIONAL PRINCIPLES FOR MULTICHANNEL FESHBACH EQUATIONS FOR SCATTERING AND REARRANGEMENT COLLISIONS. Chung, Kwong T. (North Carolina State Univ., Raleigh); Chen, Joseph C. Y. Phys. Rev., A; 6: No. 2, 686-93(Aug 1972).

Variational functionals are constructed for solving Feshbach equations for multichannel scattering and rearrangement collisions. The open-channel and closed-channel components of the state function are varied separately. This separation disentangles the violent fluctuation in the open-channel component from the closed-channel component and speeds up the convergence in the resonance energy region. Numerical illustrations are given for the elastic (e, H) scattering. (auth)

41711 VIBRATIONAL EXCITATION IN N_2 BY ELECTRON IMPACT IN THE 15- TO 35-eV REGION. Pavlovic, Z.; Boness, M. J. W.; Herzenberg, A.; Schulz, G. J. (Yale Univ., New Haven). Phys. Rev., A; 6: No. 2, 676-85(Aug 1972).

The vibrational cross section for electron impact on N_2 exhibits a broad maximum near 22 eV. This maximum can be observed in the first three vibrational states, at all angles of observation. The angular distribution of the electrons having excited nitrogen to the vibrational states v = 1, 2, 3 is measured. The shape of the angular distribution changes as the incident energy is varied from 20 to 28 eV. The observations are interpreted in terms of the possible existence of a number of overlapping compound states above 20 eV. (auth)

41712 ANGULAR DISTRIBUTIONS OF SECONDARY ELECTRONS IN THE DIPOLE APPROXIMATION. Kim, Yong-ki (Univ. of Chicago. Argonne National Lab., Ill.). Phys. Rev., A; 6: No. 2, 666-70(Aug 1972).

A close relationship between the angular distributions of secondary electrons produced by photoionization and by impact of fast charged particles is pointed out. The dipole-interaction term in the charged-particle impact cross section [which has (lnT)/T dependence, T being proportional to the incident energy] has essentially the same angular dependence as the photoelectrons ejected by unpolarized light. An analysis of recent electron-impact data on He and N_2 indicates consistency with the present theory. (auth)

41713 EIKONAL APPROXIMATION FOR COUPLED EQUATIONS FOR MULTICHANNEL SCATTERING. Ling, Rung T. (Univ. of California, San Diego, La Jolla); Chen, Joseph C. Y.; Peacher, Jerry L.; Watson, Kenneth M. Phys. Rev., A; 6: No. 2, 650-8(Aug 1972).

It is well known that the Glauber approximation for scattering amplitudes is obtained by applying the eikonal approximation to the Fourier transform of the transition operator. The eikonal approximation can also be applied to the coupled equations of scattering obtained by the expansion of the state function in terms of a suitable set of functions. The scattering amplitude can thus be obtained by solving the set of eikonal coupled equations. The latter approach is analyzed for a special class of channel-coupling potentials. The first-order approximation to the derived eikonal coupled equations is the eikonal Born approximation. Numerical illustrations in this approximation are given for the 1s−2s and 1s−2p excitations of hydrogen atoms by electron and positron impact. The results are compared with those obtained in the Glauber eikonal approximation and with experimental measurements. (auth)

41714 METHODS IN COMPUTATIONAL PHYSICS. ADVANCES IN RESEARCH AND APPLICATIONS. VOLUME 10. ATOMIC AND MOLECULAR SCATTERING. Alder, Berni; Fernbach, Sidney; Rotenberg, Manuel (eds.). New York; Academic Press, Inc. (1971). 350p. $22.00.

Separate abstracts were prepared for six of the seven articles included. The remaining article deals with quantum calculations in chemically reactive systems. (A.G.W.)

For abstracts of individual chapters see: 41715—41720.

41715 NUMERICAL SOLUTIONS OF THE INTEGRO-DIFFERENTIAL EQUATIONS OF ELECTRON–ATOM COLLISION THEORY. Burke, P. G. (Queen's Univ., Belfast); Seaton, M. J. Methods Comput. Phys.; 10: 1-80(1971).

A description of the form of the equations involved in electron–atom collision theory is followed by a review of methods of solution. Iterative methods and two noniterative methods, one in which the integrodifferential system of equations is reduced to a larger system of differential equations and another in which they are reduced to a system of linear algebraic equations, are discussed. Solutions in the asymptotic region and approximate methods of solution are considered. Information about available computer programs is given. (86 references) (A.G.W.)

41716 QUANTUM SCATTERING USING PIECEWISE ANALYTIC SOLUTIONS. Gordon, Roy G. (Harvard Univ., Cambridge, Mass.). Methods Comput. Phys.; 10: 81-109 (1971).

In the approach described here, the potential energy for a scattering problem is approximated by a set of polynomials in the variable R, the distance between the colliding particles. Each of these polynomial approximations is designed to apply over a different interval in R. Together these approximating polynomials cover the whole range of interest in R. Those considerations necessary for translating the formal results of this procedure into a generally applicable, efficient, and numerically stable method for solving quantum mechanical scattering problems are presented in detail. (A.G.W.)

41717 EXPANSION METHODS FOR ELECTRON–ATOM SCATTERING. Harris, Frank E. (Univ. of Utah, Salt Lake City); Michels, H. H. Methods Comput. Phys.; 10: 143-210 (1971).

The theory and the detailed calculational techniques involved in the use of algebraic expansions in scattering problems are surveyed. The way in which cross sections and related data are obtained from stationary-state solutions of quantum mechanical electron–atom scattering problems is reviewed. Methods for finding these stationary-state wave functions and techniques for evaluation of the integrals and matrix elements needed in actual calculations are discussed. Practical information about computer programs and their execution times and results of representative calculations are included. (45 references) (A.G.W.)

41718 CALCULATION OF CROSS SECTIONS FOR ROTATIONAL EXCITATION OF DIATOMIC MOLECULES BY HEAVY PARTICLE IMPACT: SOLUTION OF THE CLOSE-COUPLED EQUATIONS. Lester, William A. Jr. (IBM Research Lab., San Jose, Calif.). Methods Comput. Phys.; 10: 211-41(1971).

Numerical procedures employed in computer programs for solution of close-coupled equations needed in calculation of cross sections for rotational excitation of diatomic molecules by impact with atoms or ions are reviewed. Tables of some scattering probability matrices are included for purposes of comparison tests. (4 tables, 83 references) (A.G.W.)

41719 AMPLITUDE DENSITIES IN MOLECULAR SCATTERING. Secrest, Don (Univ. of Illinois, Urbana). Methods Comput. Phys.; 10: 243-86(1971).

Two integral equations and two differential equations that appear to be most useful for computing amplitude density functions are derived. Some of the most promising currently used numerical techniques involved in using these functions are reviewed. The methods are presented as applied to molecule–molecule collisions, but they could be employed for atoms or nuclei just as well. (13 references) (A.G.W.)

41720 CLASSICAL TRAJECTORY METHODS. Bunker, Don L. (Univ. of California, Irvine). Methods Comput. Phys.; 10: 287-325(1971).

The technology of the classical trajectory method is given in three parts: sampling the reaction events, solving the equations of motion and evaluating the results, and representing the potential-energy surface in a usable way. Applications to kinetics are then surveyed, both to identify special problems that arise in each area and to give an idea of the diversity of information that this technique yields. (48 references) (A.G.W.)

41721 EXCITATION TRANSFER AND PENNING IONIZATION REACTIONS BETWEEN HELIUM METASTABLES AND CARBON MONOXIDE. Hurt, W. B.; Grable, W. C. (Univ. of Texas, Dallas). J. Chem. Phys.; 57: No. 2, 734-7(15 Jul 1972).

Absolute intensity measurements were made of the radiating states of the carbon atom and carbon monoxide ion produced in a flowing afterglow by the reaction, $He(2^3S) + CO$. These measurements coupled with absorption measurements of the $He(2^3S)$ and CO densities are sufficient for calculating the rate constants for the production of the excited products mentioned above. It is found that, of the total reaction rate between $He(2^3S)$ and CO, 4% of this rate corresponds to the production of a dissociated CO molecule with the carbon atom in an excited state, and the remaining percentage of the total rate corresponds to Penning reactions into the three energetically available electronic levels of CO^+ with about equal probabilities. (auth)

41722 INTERMOLECULAR POTENTIALS FROM CROSSED-BEAM DIFFERENTIAL ELASTIC-SCATTERING MEASUREMENTS. VI. ATOMS AND DIATOMIC MOLECULES. $Ar + N_2$, $Ar + O_2$, $Kr + N_2$, AND $Kr + O_2$. Tully, F. P.; Lee, Y. T. (Univ. of Chicago). J. Chem. Phys.; 57: No. 2, 866-9(15 Jul 1972).

Differential-cross-section measurements of atom–diatomic-molecule scattering were made for the colliding pairs $Ar + N_2$, $Ar + O_2$, $Kr + N_2$, and $Kr + O_2$. Potential parameters were obtained for various Lennard-Jones (n,6) potentials, and it was found that the Lennard-Jones (20,6) and (12,6) potentials gave best agreement with the angular locations of the rainbow extrema. (auth)

41723 VIBRATIONAL DISTRIBUTION OF N_2^+ B $^2\Sigma$ PRODUCTS FROM Ne^+-N_2 COLLISIONS. Saban, G. H.; Moran, T. F. (Georgia Inst. of Tech., Atlanta). J. Chem. Phys.; 57: No. 2, 895-8(15 Jul 1972).

A crossed ion-beam–molecular-beam apparatus was used to study light emitted from radiative transitions of N_2^+ B $^2\Sigma$ products formed in reactions of Ne^+ with N_2. The cross section for this reaction was measured for collisions of 12- to 450-eV Ne^+ ions having well defined kinetic energies. Vibrational population distributions, determined from spectroscopic analysis of light emitted by the excited reaction products, were intermediate between those predicted by an application of the Franck–Condon principle and those computed using the statistical phase-space model for ion–molecule interactions. (auth)

41724 TOTAL CROSS SECTIONS FOR ELASTIC SCATTERING OF ELECTRONS BY HELIUM ATOMS. Khare, S. P.; Shobha, P. (Meerut Univ., India). pp 35-41 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

Total cross sections for the elastic scattering of electrons by helium atoms in the energy range 50 to 700 eV are calculated in the plane-wave approximation. In this approach, as in the first Born approximation, the free electron is represented by plane waves. However, the interaction potential consists of the first-order static field and the second-order adiabatic polarization and nonadiabatic distortion potentials. The Ochkur approximation is employed to calculate the exchange scattering amplitude. The terms higher than the third order in the interaction energy are neglected. For the whole energy range the present cross sections are appreciably higher than the first Born values but agree within about 6% with those obtained in the extended polarization approximation for energies equal to and greater than 75 eV. The agreement with the limited experimental data is also satisfactory. (auth)

41725 VIBRATIONAL CORRECTION TO THE ELECTRON SCATTERING INTENSITY OF THE H_2 MOLECULE. Liu, J. W.; Bonham, R. A. (Indiana Univ., Bloomington). Chem. Phys. Lett.; 14: No. 3, 346-9(1 Jun 1972).

Recently the electron scattered intensity for the H_2 molecule has been calculated in the first Born approximation utilizing a ten-term configuration-interaction (CI) wave function. In this paper the vibrational correction to this intensity is carried out using a five-term CI wave function instead of the 10-term CI wave function because of the unavailability of the 10-term wave function at internuclear distances other than the equilibrium value. The vibrational correction to the binding energy is approximately equal to the zero point vibrational energy obtained from diatomic spectra. Comparison with available experimental data indicates that more accurate experiments must be carried out before vibrational effects can be adequately documented. In addition, the sensitivity of the scattered electron intensity for the H_2 molecule to the choice of the wave function is shown. (auth)

41726 REACTION PROBABILITIES AND HIGH-ENERGY TRAJECTORIES FOR COLLINEAR H-H_2 COLLISIONS. Careless, P. N.; Hyatt, D. (Polytechnic, London). Chem. Phys. Lett.; 14: No. 3, 358-61(1 Jun 1972).

Classical trajectory studies of the collinear H + H_2 system, under the influence of a Sato potential, have been used to obtain reaction probabilities over a wide range of collision energies. Although the low-energy trajectories are simple, some high-energy trajectories are complicated and lead to the reactants being in close proximity for long enough to be considered a complex. The excess energy may be liberated in vibrational or translational form. (auth)

41727 MEASUREMENT OF DIFFERENTIAL FUNCTIONS OF EXCITATION AND IONIZATION BY A METHOD OF DOUBLE MODULATION OF AN ELECTRON BEAM. Zaslavskii, V. Ya. Kratk. Soobshch. Fiz.; No. 12, 49-55(Dec 1971). (In Russian).

Measurements of differential functions of excitation or ionization by electrons may be based on the modulation of an electron beam with signal recording at the modulation frequency. This allows a nonselective receiver to determine the total cross section with a resolution exceeding 0.005 eV. The method utilizes a Maxwellian distribution of thermoelectron velocities that may be altered by a retarding negative field. It is possible to cut off electrons of a particular energy, and modulation of such a current is described. (K.S.W.)

41728 INTERACTION OF POSITRONS WITH ARGON. Hewson, P. W.; Jones, G.; Vogt, E. W. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 50: No. 8, 821-5(15 Apr 1972).

A semi-phenomenological model of the interaction of positrons with atoms is outlined, and some model properties—enhancement factors, effective mass, and effective charge—are calculated using a local density approximation. These properties are used with a one-parameter polarization potential to predict the electric-field dependence and the temperature dependence of the positron annihilation rate in argon gas. Comparison of these predictions with experimental data shows good agreement for the electric-field dependence, but the predicted temperature-dependent effect is less than published experimental results. The model is also applied to helium, with unsatisfactory results, and a prediction of the electric field dependence of the positron annihilation rate in krypton is made. (auth)

Atomic Theory

Refer also to abstract 42021.

41729 (SC-RR-710835) M-SHELL AUGER, COSTER-KRONIG, AND RADIATIVE MATRIX ELEMENTS, AND AUGER AND COSTER-KRONIG TRANSITION RATES IN j-j COUPLING. McGuire, Eugene J. (Sandia Labs., Albuquerque, N. Mex.). Jun 1972. 98p. Dep. NTIS.

All the matrix elements used to compute M-shell fluorescence yields are presented. Also included are the transition rates in j−j coupling. (42 tables) (auth)

41730 APPROXIMATE PERTURBATION THEORY FOR HIGH-ORDER ELECTROMAGNETIC TRANSITIONS. Reiss, Howard R. (American Univ., Washington, D. C.). Phys. Rev., A; 6: No. 2, 817-22(Aug 1972).

An approximation method is developed, which yields very simple and general analytical results for electromagnetic bound-bound or bound-free transitions for any arbitrarily high order of interaction with the electromagnetic field. The approximation is perturbative in the sense that transition probabilities are proportional to the field intensity raised to the power N, where N is the order of the interaction. Limiting values of electromagnetic field strength are given within which the approximation is valid. These limits depend upon the binding potential that produces the bound states. A feature of the results is that they show the onset of high-order dominance effects, which can occur at high-field intensities. (auth)

41731 ALGEBRAIC 1 MATRICES AND RADIAL MOMENTUM DISTRIBUTIONS FROM HYLLERAAS-TYPE WAVE FUNCTIONS. ^1S GROUND STATES OF He AND He-LIKE IONS. Benesch, Robert (Univ. of Waterloo, Ont.). Phys. Rev., A; 6: No. 2, 573-80 (Aug 1972).

Spin-free 1 matrices $\gamma(\vec{r}|\vec{r}')$'s are obtained in algebraic form from simple Hylleraas-type (HY) wave functions for the ^1S ground states of He and several He-like ions. The algebraic $\gamma(\vec{r}|\vec{r}')$'s are then Fourier transformed to momentum space in order to obtain radial momentum distributions $I_0(p)$'s. The analytical method developed here allows $I_0(p)$'s to be calculated in a direct manner from HY wave functions. Although the present emphasis is on the method rather than on the "goodness" of individual $I_0(p)$'s, results for the ^1S He and Li^+ ground states are obtained from six-term HY functions, which incorporate 99.1 and 98.0%, respectively, of the correlation energy. (auth)

41732 MULTICONFIGURATION SELF-CONSISTENT-FIELD THEORY FOR LOCALIZED ORBITALS. I. THE ORBITAL EQUATIONS. Gilbert, T. L. (Argonne National Lab., Ill.). Phys. Rev., A; 6: No. 2, 580-600 (Aug 1972).

Variational equations are derived for the optimum orbitals for constructing a multiconfiguration expansion of the wave function for a many-electron system. Both the case where all Slater determinants are constructed from a common set of orbitals and the case where each determinant is constructed from an independent set of orbitals are considered. An equation with a single orbital operator is obtained in the former case, a separate operator for each determinant in the latter. The latter case corresponds to a physical picture in which the orbitals fluctuate as the system makes virtual transitions from one Slater determinant to another. The invariance properties of the wave function and of the variational equations with respect to linear transformations of the orbitals are analyzed, and various procedures are given for obtaining equations that select a unique set of orbitals. A prescription of Adams can be used in either case to localize the orbitals at a selected physical subsystem (an atomic shell, an atom, or a group of atoms). Another prescription can be used with a common set of orbitals to obtain an equation for natural spin orbitals. (auth)

41733 USE OF MULTIPLE BASIS SETS IN THE BRUECKNER-GOLDSTONE MANY-BODY PERTURBATION THEORY FOR ATOMIC PROBLEMS. Ishihara, T.; Poe, R. T. (Univ. of California, Riverside). Phys. Rev., A; 6: No. 1, 111-16(Jul 1972).

In the Brueckner−Goldstone many-body perturbation theory as applied to atomic calculations, the origin of important higher-order diagrams is associated with the inflexibility of the single basis set upon which the perturbation expansion is normally based. It is shown that in calculating each diagram more than one basis set may be employed simultaneously. The use of multiple basis sets is identical to the exact inclusion of a large class of important higher-order terms. Illustrated examples are given to show where this technique will be of practical importance. This possibility is expected to improve the accuracy and to extend the range of applicability of the Brueckner−Goldstone many-body perturbation-theory approach. (auth)

41734 DIAGRAMMATICAL METHOD FOR GEMINALS. I. THEORY. Paldus, J. (Univ. of Waterloo, Ont.). J. Chem. Phys.; 57: No. 2, 638-51(15 Jul 1972).

A diagrammatical method, based on the second quantization formalism, time-independent Wick's theorem and Feynman-like diagrams, is developed for the calculation of arbitrary matrix elements of n-particle spin-independent operators between the states represented by antisymmetrized products of geminals of an arbitrary kind (i.e., strongly or weakly orthogonal, interacting, nonorthogonal, or identical geminals). The method greatly facilitates any algebraic manipulation with geminal-type functions, particularly when strong orthogonality is not assumed, and enables one to write down directly the algebraic expressions for the matrix elements of an arbitrary spin-independent operator between the single antisymmetrized products of arbitrary geminals, solely on the basis of simple graphs, which are easily constructed. (auth)

41735 DIAGRAMMATICAL METHOD FOR GEMINALS. II. APPLICATIONS. Paldus, J.; Sengupta, S.; Cizek, J. (Univ. of Waterloo, Ont.). J. Chem. Phys.; 57: No. 2, 652-66(15 Jul 1972).

The diagrammatical method for the calculation of the matrix elements of an arbitrary spin-independent operator in the basis of single antisymmetrized geminal products, developed in Part I, is applied to derive the overlap and energy mean value expressions for various types of geminal wave functions, namely for strongly and weakly orthogonal, nonorthogonal, and identical geminals. The applications to other problems and the use of molecular symmetry in this formalism are also briefly discussed. (auth)

41736 CONSERVATION RULE FOR THE TOTAL CROSS SECTION IN MOLECULAR COLLISION THEORY. Levine, R. D. (Weizmann Inst. of Science, Rehovot, Israel). J. Chem. Phys.; 57: No. 2, 1015-16(15 Jul 1972).

A quick proof of the conservation rule that states that knowledge of the elastic phase shift is sufficient to determine the total cross section, irrespective of the actual products of the collision, is presented for the case of atom–diatom inelastic collisions. Conditions under which the rule holds for partial cross sections are considered briefly. (A.G.W.)

41737 MAGNETISM OF A NUCLEI PLUS ELECTRONS SYSTEM. II. NUMERICAL ANALYSES. Murao, Tsuyoshi (Kyoto Univ.). J. Phys. Soc. Jap.; 33: No. 1, 33-8(Jul 1972).

The results of an earlier paper on a combined system of nuclear spins and electron spins are analyzed numerically in the Weiss approximation at the "electronic region" ($2\bar{J}/D > 1$) as well as the "nuclear region ($2\bar{J}/D < 1$). The Curie temperature and the electron spin polarization at T = 0K are smoothly continuous against $2J/D$, but change steeply across the threshold condition $2J/D = 1$. Some peculiar features are found in temperature dependence of the electron spin and of the nuclear spin polarizations and in the "nuclear" specific heat, particularly when $2\bar{J}/D$ is close to unity. (auth)

41738 OPTIMIZING THE TREATMENT OF EXCHANGE PERTURBATIONS. Hirschfelder, J. O.; Chipman, D. M. (Univ. of Wisconsin, Madison. Univ. of California, Santa Barbara). Chem. Phys. Lett.; 14: No. 3, 293-8(1 Jun 1972).

In a practical treatment of exchange perturbation problems one seeks the best wave function of the form $\Psi(1) = A(\phi_0 + \phi_1)$ where A is a symmetry projection operator, ϕ_0 is the eigenfunction of the unperturbed hamiltonian, H_0, and ϕ_1 is the solution to a first-order perturbation equation of the form $(H_0-E_0)\phi_1 + (V-E_1)\phi_0 = (1-A)F_1$. Most previous treatments correspond to assuming that $F_1 = \Sigma_{\nu,j}\, {}^{\nu}A_{1j}({}^{\nu}\alpha_j + {}^{\nu}\beta_j V)\phi_0$. Here ν labels the irreducible representation, j labels the row of the representation. The choice of the constants ${}^{\nu}\alpha_j$ and ${}^{\nu}\beta_j$ depends upon the particular method. The function F_1 is determined so that the resulting $\Psi(1)$ is equal to the exact wave function or any given function having the symmetry of A. It is hoped that this analysis will suggest desirable forms for F_1 to use in practical problems. Attempts to determine ϕ_1 by optimizing the sum of the first- and second-order energies were not successful. (auth)

41739 N-PARTICLE NONINTERACTING GREEN'S FUNCTION. Cooper, W. Grant (Univ. of Houston, Tex.); Kouri, Donald J. J. Math. Phys. (N. Y.); 13: No. 6, 809-13(Jun 1972).

A prescription is given for obtaining the Green's function for N free particles that can have different masses. The approach is systematic and straightforward. A coordinate transformation of the Fourier integral representation of the N-particle noninteracting Green's function facilitates the integration over 3N-1 angular variables of wave number space. A single radial integral can then be evaluated. The resulting Green's function representation may be of use in applying the integral form of Schrödinger's equation to calculate the ground and excited states of atoms. (auth)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

Refer also to abstract 41681.

41740 (JPRS-56352) ELECTRIC DISCHARGE SHOCK TUBE AS A PLASMA SOURCE FOR MAGNETOHYDRODYNAMIC EXPERIMENTS. Maksimov, A. M. Translated from Teplofiz. Vys. Temp.; 9: No. 5, 1023-8(1971). 9p. NTIS.

Results from a complex investigation of the parameters of a shock-heated gas in a diaphragmless electric discharge shock tube are discussed; the initial pressure range was 0.5 to 5 mm Hg and the Mach number range was 6 to 13. The velocity of the wake of the plasma, the gas pressure, the thermal flux to the wall of the shock tube and also the extent of the plug were measured. It was demonstrated that, in the region investigated, the Rankine–Hugoniot equations can be used to calculate the properties of the gas flow. The process of ionization relaxation beyond the shock wave front was studied. Experiments were performed to study the interaction of the plasma flux with crossed electric and magnetic fields. (auth)

41741 MHD FLOW PAST A FLAT PLATE IN THE PRESENCE OF A NONALIGNED MAGNETIC FIELD. Ranger, K. B. (Univ. of Toronto). Appl. Sci. Res. (The Hague); 25: No. 5, 355-60(Feb 1972).

An explicit solution in terms of the stream function is found for the streaming MHD flow past a semi-infinite flat plate in the presence of a perpendicular uniform magnetic field. Asymptotic forms of the velocity field at large distances are obtained, and a related problem involving a semi-infinite needle is also discussed. (auth)

41742 YAVNOPOLYUSNYE MGD-NASOSY. (Salient-Pole MHD Pumps). Kalnin, T. K. Riga; Izdatel'stvo Zinatne (1969). 172p.

Problems in the design, theory, calculation, and exploitation of a large class of induction electromagnetic pumps are discussed. A calculation method, based on theoretical and experimental studies, is developed that can be used for design calculations of a given class of electromagnetic pumps. The method can also be used as a starting point for a deeper study of physical phenomena in the working area of pumps. Sample calculations and tables given in the supplement facilitate the design and engineering calculation of the given type of electromagnetic pumps. 8 tables, 56 figures, 112 references. (auth)

41743 HYDROMAGNETIC FREE CONVECTION FROM A FLAT PLATE. Takhar, H. S. (Univ. of Manchester, Eng.). Indian J. Phys.; 45: No. 7, 289-311(Jul 1971).

Natural convection produced by the action of thermal buoyancy and induced magnetic body forces, acting on an electrically conducting nonmagnetic fluid flowing past a vertical flat plate, in the presence of a uniform horizontal magnetic field, acting normal to the plate, is considered for two thermal specifications: a uniformly heated flat plate and an insulated flat plate heated at the base by a line source of heat. The Karman–Pohlhausen type of approximate solutions, based on the integrated forms of the governing equations, suggests the form of the similarity variables used in solving the boundary-layer equations numerically, using the Runge–Kutta iterative techniques. Graphs are presented for the dimensionless velocity and temperature distributions for parametric values of the Prandtl number when the magnetic and buoyancy forces are in balance and for a value of the Prandtl number = 0.733, when these forces are allowed to dominate each other. It is found that the physical and heat transfer properties of the flow depend upon a Hartmann-type magnetic number, apart from the usual dependence of convective flow on the Prandtl, Grashof, and the dimensionless integrated heat flux numbers. It is shown that the application of a magnetic field to a thermally buoyant flow reduces the skin friction and the rate of heat transfer from the wall. (auth)

41744 MAGNETOHYDRODYNAMIC CHANNEL FLOW WITH AN ARBITRARY INLET VELOCITY PROFILE. Chen, T. S.; Chen, G. L. (Univ. of Missouri, Rolla). Phys. Fluids; 15: No. 8, 1531-4(Aug 1972).

The laminar flow development in a magnetohydrodynamic channel with an arbitrary velocity distribution at the inlet is analyzed by the linearization method. The present analysis is simple and gives accurate results for the velocity distribution and pressure drop. (auth)

41745 HYDROMAGNETIC FLOW BETWEEN TWO ROTATING DISKS WITH NONCOINCIDENT PARALLEL AXES OF ROTATION. Mohanty, Hemanta Kumar (Indian Inst. of Tech., Kharagpur). Phys. Fluids; 15: No. 8, 1456-8(Aug 1972).

Magnetohydrodynamic flow between two disks, rotating with the same angular velocity Ω about two different axes, a distance a apart, was studied under the action of a uniform axial magnetic field. An exact solution of the equations of motion is obtained in a simple closed form. It is found that the torque, experienced by the disks, increases due to the magnetic field. For large values of the governing parameters, thin boundary layers are formed at the disks. (auth)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 41842, 41852, and 41854.

41746 (SLAC–144, pp 19.1-15) STATUS OF HIGH ENERGY PHYSICS IN JAPAN. Kitagaki, Toshio (Tohoku Univ., Sendai (Japan)). Mar 1972.

From Joint Japanese–U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

A brief summary is given of the status of particle physics in Japan. The design of a new separated function accelerator to be built and the design of a new bubble chamber under construction are also described. (J.F.P.)

41747 CORRELATIONS IN INELASTIC INTERACTIONS AT ENERGY OF 0.5×10^{12} eV. Berdzenishvili, O. L.; Gabuniya, L. L.; Garibashvili, D. I.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2010-16(Oct 1971). (In Russian).

Correlations between momentum and angular characteristics, and correlations between pairs of secondary particles, momentum spectra, and the nature of similarity were investigated for inelastic interactions having energies of 0.5×10^{12} eV. (tr-auth)

Electromagnetic

41748 (BNL-tr-481) FUNDAMENTAL ELECTROMAGNETIC PROPERTIES OF A NEUTRON: ELECTRIC CHARGE, ELECTRIC DIPOLE MOMENT, ELECTROMAGNETIC FORM FACTORS, POLARIZABILITY, NEUTRON–ELECTRON INTERACTION. Aleksandrov, Yu. A. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Probl. Fiz. Elem. Chastits At. Yadra; 1: No. 2, 547-83(1971). 44p. Dep. NTIS.

Experimental papers devoted to fundamental electromagnetic properties of a neutron, such as: electrical charge, electrical dipole moment, electromagnetic form factors, polarizability, and (n–e) interaction are reviewed. (auth)

41749 (CONF-710816-10) REACTION $\gamma p \rightarrow \pi^+\pi^-\pi^+\pi^- p$ AT HIGH ENERGY AND PHOTON DISSOCIATION INTO 4 PIONS. Davier, M.; Derado, I.; Fries, D. C.; Liu, F. F.; Mozley, R. F.; Odian, A. C.; Park, J.; Swanson, W. P.; Villa, F.; Yount, D. (Stanford Linear Accelerator Center, Calif.). 30 Jun 1971. 14p.

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

The reaction $\gamma + p \rightarrow 2\pi^+ + 2\pi^- + p$ at 4.5 to 18 GeV in a streamer chamber was studied. The energy dependence of the cross sections and cross sections for ρ^0 and Δ^{++} production mass distributions, the mass, width, and cross section of a $\rho^0\pi^+\pi^-$ enhancement, and an upper limit on the branching ratio for the direct decay $\rho^0 \rightarrow 2\pi^+ + 2\pi^-$ are found. (J.F.P.)

41750 (SLAC–144, pp 17.1-16) PHOTOPRODUCTION OF VECTOR MESONS IN THE BUBBLE CHAMBER. Chadwick, G. (Stanford Linear Accelerator Center, Calif.). Mar 1972.

From Joint Japanese–U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

The reaction $\gamma + p \leftrightarrow p + \mu^0$ at 9.3 GeV/c in a hydrogen bubble chamber is discussed. An attempt is made to show why the bubble chamber is the best technique to use, its shortcomings are investigated, and an inquiry is made into the future prospects of its use. The cross sections dipion spectrum, angular distributions, and decay angular distributions for ρ^0 are discussed. (J.F.P.)

41751 SEARCH FOR RELATIVISTIC CHARGE-$\frac{2}{3}$e QUARKS IN THE COSMIC RADIATION. Crouch, M. F.; Mori, K.; Smith, G. R. (Case Western Reserve Univ., Cleveland). Phys. Rev., D; 5: No. 11, 2667-76(1 Jun 1972).

A multilayer liquid scintillation detector telescope of aperture 0.51 m^2 sr combined with a flash-tube track detector was used to search for relativistic charge-$\frac{2}{3}$e quarks in the cosmic radiation. The results set an upper limit on the vertical intensity of such particles of 2.2×10^{-6} sec^{-1} m^{-2} sr^{-1} at a 90% confidence level. (auth)

41752 ELECTRON SHOWERS OF HIGH PRIMARY ENERGY IN LEAD. Mueller, Dietrich (Univ. of Chicago). Phys. Rev., D; 5: No. 11, 2677-83(1 Jun 1972).

The development of electron cascade showers in a lead-scintillator sandwich of 8 plastic scintillators in about 20 radiation lengths of lead was investigated. This detector, which was used for cosmic-ray studies, was calibrated with electrons with energies from 2 to 15 GeV at SLAC. Measured shower profiles are presented, and expressions are given which allow an extrapolation of the measured data up to energies around 1000 GeV. The results are compared with analytical shower theories and Monte Carlo calculations. (auth)

41753 GROUPS OF HIGH-ENERGY PENETRATING PARTICLES. Bibilashvili, M. F.; Barnaveli, T. T.; Muradova, N. A.; Khaldeeva, I. V. (Inst. of Physics, Tbilisi, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2160-3(Oct 1971). (In Russian).

Comparative data on groups of high energy penetrating particles were obtained in conjunction with information on extensive air showers at various subterranean levels. From these data there was derived an energy spectrum for μ-mesons. The distribution of average distances between particles in groups, and the output of extensive air showers (expressed in the number of particles at an observation level) as a function of the number of particles in a group, are discussed. (K.S.W.)

41754 COMPARISON OF CALCULATED AND EXPERIMENTAL CHARACTERISTICS OF EXTENSIVE AIR SHOWERS AT DIFFERENT LEVELS OF OBSERVATION. Popova, L. (Inst. of Physics, Sofia). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2134-7(Oct 1971). (In Russian).

Calculated cascade curves (with E_0 = constant) were compared with experimental curves for a given absolute intensity, assuming that showers with a fixed frequency were formed by primary particles with identical energies. Shower spectra were considered according to the number of particles detected. The parameters of growth of a shower varied differently for different models. Numbers of muons are discussed in terms of their primary energy and the number of particles in a shower. The energy spectrum of high energy muons is related to the composition of an extensive air shower. (K.S.W.)

41755 SPECTRA OF EXTENSIVE AIR SHOWERS WITH RESPECT TO THE NUMBERS OF ELECTRONS AND MUONS. Aseikin, V. S.; Benko, D.; Kabanova, N. V.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2128-33(Oct 1971). (In Russian).

Extensive air shower spectra were studied with respect to the number of electrons in the region $N_e = 10^5$ to 3×10^6, and the number of muons with $E_\mu \geq 5$ GeV in the region $N_\mu = 6 \times 10^3$ to 5×10^4. It was not possible to approximate either the N_e spectrum or the N_μ spectrum with a power function with a single exponent. The exponent altered its value for $N_{e_{gr}} = (8 \text{ to } 10) \times 10^5$ and $N_{\mu_{gr}} = 2.4 \times 10^4$. (tr-auth).

41756 SPECTRUM OF PRIMARY COSMIC RADIATION DERIVED FROM EXTENSIVE AIR SHOWERS. Nikol'skii, S. I. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2117-22(Oct 1971). (In Russian).

The approximation $F(>E_0) = 7.5(10^{11}\,\partial\beta/E_0)^{1.6\pm0.03} \cdot \Sigma_z B_z\ [I + E_0/Z\ 10^{18}\,\partial\beta/(1 + E_0/Z\ 10^{14}\,\partial\beta)^{0.5}]\ m^{-2} \cdot sec^{-1} \cdot ster^{-1}$, is discussed as the most probable representation of the energy spectrum of primary cosmic radiation over the broad energy interval 10^{11} eV $< E_0 < 10^{20}$ eV, taking account of the concept of primary nuclei with diverse charge Z. (tr-auth)

41757 CHARACTERISTICS OF INDIVIDUAL EXTENSIVE AIR SHOWERS AT AIRCRAFT ALTITUDES. Antonov, R. A.; Ivanenko, I. P.; Samosudov, B. E.; Tulinova, Z. I. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2113-16(Oct 1971). (In Russian).

Data on the altitude of extensive air showers were obtained with the use of an airplane. An integral spectrum of vertical showers with respect to the number of particles at a height of 10 km was determined. The data are in better agreement with those calculated under the assumption that at energies of about 10^3 TeV a significant portion of interactions occurs with extremely fine subdivision of energy. (tr-auth)

41758 STRUCTURAL FUNCTIONS OF ELECTRONS AND MUONS IN EXTENSIVE AIR SHOWERS WITH INITIAL ENERGIES OF 10^{15} TO 10^{17} eV. Khristiansen, G. B.; Vedeneev, O. V.; Kulikov, G. V.; Nazarov, V. I.; Solov'eva, V. I. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2107-12(Oct 1971). (In Russian).

Experimental data on density fluctuation and trajectory distribution of particle showers were obtained along the azimuth at distances of about 200 m from the shower axis. Functions of the spatial distribution of electrons and muons are discussed for showers with a total particle number $N_e = 10^5$ to 10^7. (tr-auth)

41759 INVESTIGATION OF RADIOEMISSION OF EXTENSIVE AIR SHOWERS AT THE MOSCOW UNIV. COMPLEX INSTALLATION. Khristiansen, G. B.; Atrashkevich, V. B.; Vedneev, O. V.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2102-6(Oct 1971). (In Russian).

Results of an investigation of the radio radiation of extensive air showers at the Moscow Univ. installation are presented. The polarization of the radio radiation, its spatial distribution, and correlation of the latter with certain parameters of extensive air showers are discussed. Fluctuations in the radio radiation also receive attention. (tr-auth)

41760 PRELIMINARY RESULTS IN RECORDING EXTENSIVE AIR SHOWERS AT COMPLEX INSTALLATION IN YAKUTSK. Vernov, S. N.; Egorov, T. A.; Efimov, N. N.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2098-2101(Oct 1971). (In Russian).

A new apparatus designated as "SHAL-2" was constructed for investigating the energy spectrum, composition, and anisotropy of cosmic radiation in the energy range 10^{17} to 10^{18} eV. The three parts of the apparatus include an arrangement for recording the charged component of an extensive air shower, equipment for recording the accompanying Cherenkov radiation, and means for determining the time lag of particle penetration. The energy spectrum of primary particles and the analysis of the Cherenkov light of an extensive air shower are discussed. (K.S.W.)

41761 PRECISE MEASUREMENT OF THE ANOMALOUS MAGNETIC MOMENT OF THE MUON. Bailey, J.; Bartl, W.; von Bochmann, G.; (and others) (CERN, Geneva). Nuovo Cim.; 9A: No. 4, 369-432(21 Jun 1972).

The anomalous magnetic moment $a \equiv \frac{1}{2}(g - 2)$ of the muon was measured in the CERN muon storage ring. The result is $(116{,}616 \pm 31) \cdot 10^{-8}$ compared with the theoretical value $(116{,}588 \pm 2) \cdot 10^{-8}$ showing agreement to (240 ± 270) parts per million. The lifetime of muons moving in a circular orbit $\gamma = 12$ was found to agree with the time dilation predicted by special relativity to within 1.1%. Details are given of the storage ring magnet, the instrumentation and the data analysis. The theoretical implications of the result are discussed. (auth)

41762 e–e SCATTERING CROSS-SECTION MEASUREMENTS USING PAGE-TYPE GEOMETRY. Bhiday, M. R.; Bhatnagar, K. G.; Chaudhari, N. M. (Univ. of Poona). Proc. Indian Acad. Sci., Sect. A.; 75: No. 3, 138-49(Mar 1972).

Experiments to measure differential scattering cross sections in electron–electron and positron–electron scattering were performed. Page type geometry was employed because of its line focussing property. Moderately intense radioactive sources could, therefore, be used. Measurements of cross sections were carried out over a continuous range of values of q, the kinetic energy transfer. The measurements of electron–electron scattering cross sections for energies in the range (0.2 to 0.65) MeV using thin mylar and aluminum foils of different thickness were reported. The Moeller formula was verified within ±4%. (auth)

41763 ELECTROEXCITATION OF THE ISOBAR Δ FROM PROTON. Titov, Yu. I.; Severin, N. F.; Afanas'ev, N. G.; (and others) (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 11, 1888-92(Nov 1971). (In Russian).

The inelastic scattering of electrons by protons in the region of Δ_{1236} was measured at incident electron energies of 1000 MeV and 1170 MeV and angles 16 to 25°. Data are compared with SU(6)-symmetry and the Walecka–Zucker model predictions. A method is suggested to separate resonant and nonresonant contributions. (auth)

41764 AXIAL NUCLEON FORM FACTOR FROM THE PION ELECTROPRODUCTION NEAR THRESHOLD. Titov, Yu. I.; Severin, N. F.; Afanas'ev, N. G.; (and others) (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 11, 1893-7(Nov 1971). (In Russian).

Data are presented of the electron inelastic scattering by protons near pion threshold. The data are analyzed by current algebra calculations under the PCAC, approximations. The axial nucleon form factor is derived for momentum transfers (2.4 to 4.9)f^{-2}. These values are in agreement with the neutrino experiment results. (auth)

41765 PHOTOPRODUCTION OF ρ^0 AND ω IN γd INTERACTIONS AT 4.3 GeV. Eisenberg, Y.; Haber, B.; Kogan, E.; (and others) Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; B42: 349-68(1 Jun 1972).

Coherent photoproduction of ρ^0 and ω at $E_\gamma = 4.3$ GeV is observed. The ratios $p^0d/\omega d$ and ρ^0d/ρ^0p are discussed and compared with theoretical predictions. By comparing the data with total photoabsorption cross sections the direct vector meson-photon coupling is determined to be $\gamma_\rho^2/4\pi = 0.29 \pm 0.06$. With this value the VDM relations between photoproduction and Compton scattering are found to be well satisfied. (auth)

41766 COINCIDENCE ELECTROPRODUCTION ABOVE THE RESONANCE REGION. Sofair, A. (Univ. of Manchester, Eng.); Allison, J.; Dickinson, B. Nucl. Phys.; B42: 369-96(1 Jun 1972).

Data has been obtained for coincidence electroproduction at an invariant hadronic mass, $s^{\frac{1}{2}}$, of 1.93 GeV/c², and four momentum transfer squared, $|k^2|$, 0.7 (GeV/c)². Electrons were detected in coincidence with forward produced π^- and π^+ mesons and forward and backward produced protons, for selected values of t, but almost the full range of kinematically available missing mass. Cross sections are presented for the exclusive reactions, $\gamma_v + p \rightarrow \pi^+ + n$, $\gamma_v + p \rightarrow \pi^- + \Delta^{++}$, and $\gamma_v + p \rightarrow p + \rho^0$, and for the inclusive reactions, $\gamma_v + p \rightarrow \pi^+$ anything, $\gamma_v + p \rightarrow \pi^-$ + anything, and $\gamma_v + p \rightarrow p$ + anything. (auth)

41767 TRENDS IN RESEARCH ON POSITRON ANNIHILATION. Berenyi, Denes (Nuclear Research Inst., Debrecen, Hungary). Fiz. Szemle; 22: No. 3, 75-81(Mar 1972). (In Hungarian).

Study of the positron annihilation is an old field of research; investigation on the interaction of positrons with matters started in the thirties after Dirac predicted and Anderson demonstrated the existence of the anti-electron. The large number of papers in the recent literature reveal the use of positron studies for investigating the structure of gases, liquids and solids, the interaction between antiparticles, conservation of the charge parity, etc. The radiation-free annihilation of positrons creating the triplet $^3S_1$ state was reported only recently. Thermalization after passage through matter may lead to free or quasi-free thermalized positron or the formation of a bound state with electron, the positronium. The time spectrum of quanta and the angular correlation between the 2 protons in case of the 2-photon annihilation process were widely investigated. A radioactive source, mostly ^{22}Na, but also ^{56}Co and ^{58}Co, is used as the positron force, surrounding it with the material, in which the annihilation is studied. The triple coincidence technique was reported by many investigators. Work is also in progress at very low temperatures, down to that of liquid helium. Positron annihilation data were used to study the structure of metals, determination of F centers and dislocations in nonmolecular crystals, presence of free radicals, etc. (Review article) (TTT)

Weak

Refer also to abstracts 40974, 41923, 41924, and 42032.

41768 (SLAC-144, pp 3.1-19) NEUTRINO PHYSICS IN A LARGE BUBBLE CHAMBER AT VERY HIGH ENERGIES. Baltay, C. (Columbia Univ., New York). Mar 1972.

From Joint Japanese–U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

Proposed neutrino interaction studies at NAL are discussed. A summary of possible research directions, the neutrino beam design and fluxes, estimated yield of events, and the detection capabilities of the bubble chamber with various fills and muon detectors are covered. (J.F.P.)

41769 DECAY $K_L \rightarrow \pi^0\pi^0$. Holder, M. (Technische Hochschule, Aachen); Radermacher, E.; Staude, A.; (and others). Phys. Lett.; 40B: No. 1, 141-6(12 Jun 1972).

The ratio $|\eta_{00}/\eta_{+-}|$ between the parameters $\eta_{00} = A\,(K_L \rightarrow \pi^0\pi^0)/A(K_S \rightarrow \pi^0\pi^0)$ and $\eta_{+-} = A(K_L \rightarrow \pi^+\pi^-)/A(K_S \rightarrow \pi^+\pi^-)$ was measured. The result $|\eta_{00}/\eta_{+-}| = 1.0 \pm 0.06$ is in good agreement with the prediction $|\eta_{00}| = |\eta_{+-}|$ of a number of models, for which the CP violation in the 2π channel is independent of the isospin of the final state. (auth)

41770 SEARCH FOR DIRECT PROCESSES IN $K^\pm \rightarrow \pi^\pm\pi^0\gamma$ DECAYS. Edwards, R. T.; Beier, E. W.; Bertram, W. K.; (and others) (Univ. of Illinois, Urbana). Phys. Rev., D; 5: No. 11, 2720-7(1 Jun 1972).

Thirty-three events of the type $K^+ \rightarrow \pi^+\pi^0\gamma$ and 31 of the type $K^- \rightarrow \pi^-\pi^0\gamma$ were found in an experiment using spark chambers. The angles of the observed decay products were used to determine the angle between the charged pion and the γ ray in the K rest frame. The distribution of this angle showed no indication of a direct radiative process but instead was consistent with internal bremsstrahlung. In order to be quantitative concerning the amount of direct interaction, 24 events with the charged-pion kinetic energy T_π restricted to $58 \leq T_\pi \leq 90$ MeV were selected and maximum-likelihood fits were carried out for various assumptions regarding the radiative amplitudes, final-state interaction, and amount of CP violation. Assuming no magnetic dipole the largest value found by the maximum-likelihood fit for the direct (electric dipole) amplitude is $A_E = -0.12^{+0.21}_{-0.25}$ relative to the internal-bremsstrahlung amplitude. If the direct process occurs, and if CP is appreciably violated in the $K^\pm \rightarrow \pi^\pm\pi^0\gamma$ decay, there would be a difference between the rates for $K^+ \rightarrow \pi^+\pi^0\gamma$ and $K^- \rightarrow \pi^-\pi^0\gamma$. The result is $\Gamma(K^- \rightarrow \pi^-\pi^0\gamma)/\Gamma(K^+ \rightarrow \pi^+\pi^0\gamma) - 1 = 0 \pm 0.24$. Thus a large asymmetry suggested by some theories is ruled out by this observation. (auth)

41771 NEUTRON PRODUCTION DURING MUON CAPTURE. Bobodzhanov, I. B. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2170(Oct 1971). (In Russian).

The average multiplicity of neutrons formed in a u-meson capture by Mg and Al nuclei was investigated at a height of 800 meters above sea level, with the following results: the multiplicity for Mg was 0.79 ± 0.18, and that for Al was 0.83 ± 0.19. (K.S.W.)

41772 CASCADE SHOWERS GENERATED BY MUONS. Borog, V. V.; Kirillov-Ugryumov, V. G.; Kirina, T. M.; (and others) (Moscow Engineering-Physics Inst.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2164-9(Oct 1971). (In Russian).

An arrangement with an ionization calorimeter sandwiched between two hodoscopic detectors makes possible energy determinations with an accuracy ~10% provided that maximum shower development (initiated by a photon or electron) does not extend beyond the range of the assembly. An analysis of angular distribution of cascade showers was based on 1,172 events within a specified angle to the zenith. The experimental data were also used in an analysis of the generation of cosmic muons. (K.S.W.)

41773 ENERGY AND ANGULAR DISTRIBUTIONS OF MUONS WITH ENERGIES OF 3 TO 10 TeV ACCORDING TO DATA OF THE EMULSION CAMERA WITH X-RAY FILM. Baradzei, L. T.; Kanevskaya, E. A.; Smorodin, Yu. A.; Solov'ev, M. V. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2144-50(Oct 1971). (In Russian).

An interlayered sheet lead-x ray film chamber was used in a subterranean chamber (20 m) to investigate angular and energy distribution of muons for energies >2 TeV. Interpretation of the film spots is explained in terms of π-mesons of various energies and electron cascades in showers in different energy ranges. (K.S.W.)

41774 INTERMEDIATE VECTOR BOSON. Cronin, James W. (Univ. of Chicago). pp 3-32 of Proceedings of the Fourth Hawaii Topical Conference in Particle Physics. /Yount, D. E. (ed.). Honolulu, Hawaii; Univ. of Hawaii Press (1972).

From fourth topical conference in particle physics; Honolulu, HI. (2 Aug 1971). See CONF-710819.

Experiments for a search for the W boson are reviewed in some detail. The theory for W production is briefly discussed using the CVC relation. (J.F.P.)

41775 PROPERTIES OF WEAK INTERACTIONS: SOME INVESTIGATIONS BY HIGH-ENERGY TECHNIQUES. Cronin, James W. (Univ. of Chicago). pp 62-79 of Proceedings of the Fourth Hawaii Topical Conference in Particle Physics. /Yount, D. E. (ed.). Honolulu, Hawaii; Univ. of Hawaii Press (1972).

From fourth topical conference in particle physics; Honolulu, HI. (2 Aug 1971). See CONF-710819.

The lecture on investigations of weak interactions using high-energy techniques covers baryon decay, hyperon decay rates and form factor ratios, the Cabibbo angle, Λ^0 beta decay, prospects for hyperon beta decay investigations, $K^0 \rightarrow \pi + l + \nu$ decay, $\Delta I = \frac{1}{2}$ rule in strangeness-changing semileptonic decays, and nonleptonic weak decays. (J.F.P.)

41776 $K_L \rightarrow \mu^+\mu^-$ PUZZLE. Cronin, Jack W. (Univ. of Chicago). pp 147-83 of Proceedings of the Fourth Hawaii Topical Conference in Particle Physics. /Yount, D. E. (ed.). Honolulu, Hawaii; Univ. of Hawaii Press (1972).

From fourth topical conference in particle physics; Honolulu, HI. (2 Aug 1971). See CONF-710819.

The lecture on the $K_2^0 \rightarrow \mu^+ + \mu^-$ puzzle, which is due to the observed upper limit for this decay being significantly lower than the lower limit based on very sound theory is discussed. The experiment which discovered the puzzle is reviewed, and the experiments on $K_2^0 \rightarrow 2\gamma$ decay, on which the puzzle is based, are also reviewed. (J.F.P.)

Strong (Baryon-induced)

Refer also to abstracts 40973, 40975, 42108, and 42113.

41777 (COO-1112-25) DOUBLE CHARGE EXCHANGE REACTIONS. Akerlof, Carl W. (Michigan Univ., Ann Arbor). 1970. 24p. (CONF-701108-5; UM-HE-70-19). Dep. NTIS.

From Meeting of the Division of Particles and Fields of the American Physical Society; Austin, Tex. (5 Nov 1970).

The discussion of exotic double charge exchange reactions covers two-body reactions of photoproduction, decuplet production, and two-body final states. It is found that experimentally questionable data give the only positive evidence for a significant double charge exchange cross section. The essential points of the arguments that the results of the photoproduction and decuplet production experiments are artifacts of less exotic processes are covered. Some new data on cross sections for $\pi^- + p \rightarrow K^+ + \Sigma^-$ interactions at 2.75 to 5.0 GeV/c are presented. (J.F.P.)

41778 (INP-787) GENERAL CHARACTERISTICS OF PROTON-NUCLEON INTERACTIONS IN NUCLEAR EMULSION AT 67 GeV/c. (Institute of Nuclear Physics, Krakow (Poland)). Feb 1972. 13p. Dep. NTIS (U. S. Sales Only).

Interactions of 67 GeV/c protons with nucleons are studied in nuclear emulsion. The average proton-proton multiplicity is 6.63 ± 0.16. Strong anisotropy of the angular distribution is seen. (auth)

41779 (INP-788) COHERENT PRODUCTION OF PARTICLES BY 67-GeV/c PROTONS ON EMULSION NUCLEI. Alma-Ata-Cracow-Dubna-Leningrad-Moscow (F.I.A.N. and M.G.U.)-Tashkent-Ulan-Bator Collaboration (Institute of Nuclear Physics, Krakow (Poland)). Feb 1972. 14p. Dep. NTIS (U. S. Sales Only).

Coherent reactions were observed among one-, three-, and maybe five-prong interactions of 67 GeV/c protons in nuclear emulsion. Their cross sections were estimated and compared with other data on coherent production in emulsion. (auth)

41780 (JINR-P1-6343) ENERGY DEPENDENCE OF ELASTIC BACKWARD p-d SCATTERING IN THE ENERGY RANGE OF 360 TO 670 MeV. Komarov, V. I.; Kosarev, G. E.; Reshetnikov, G. P.; Savchenko, O. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Apr 1972. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

Energy dependence is measured for the elastic pd-scattering at 168° of the c.m.s. in the energy range of incident protons being 360 to 670 MeV. The analysis of the results shows a considerable contribution of the scattering mechanism (which is due to virtual process $p + N \rightarrow d + \pi$ at one of the deuteron nucleons) in the elastic backward pd-scattering at 400 to 700 MeV. (auth)

41781 (SLAC-144) PROCEEDINGS OF THE JOINT JAPANESE-U. S. SEMINAR ON ELEMENTARY-PARTICLE PHYSICS WITH BUBBLE CHAMBER DETECTORS, STANFORD LINEAR ACCELERATOR CENTER, FEBRUARY 24-26, 1971. Chadwick, George; Skillicorn, I. O. (ed.) (Stanford Linear Accelerator Center, Calif.). Mar 1972. Contract AT(04-3)-515. 372p. (CONF-710226). Dep. NTIS.

The conference included 20 papers. Separate abstracts were prepared for all papers. (J.F.P.)

For abstracts of individual papers see: 40974, 40975, 41746, 41750, 41768, 41782, 41783, 41808–41815, 41843, 41858, and 41938–41940.

41782 (SLAC–144, pp 14.1-13) $\bar{p}p \rightarrow \bar{N}N$ INTERACTION AT LOW ENERGY. Hirose, T. (Tokyo Univ. (Japan). Inst. for Nuclear Study); Yamagata, T.; (and others) (Tokyo Metropolitan Univ. (Japan)). Mar 1972.

From Joint Japanese–U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

The angular distributions and total and differential cross sections are presented for the reactions $\bar{p} + p \rightarrow \bar{n} + n$ and $\bar{p} + p \rightarrow \bar{p} + p$ at 232 MeV in a bubble chamber. These results are preliminary. (J.F.P.)

41783 (SLAC–144, pp 22.1-5) BUBBLE CHAMBER PHYSICS AT RUTGERS–STEVENS. Plano, Richard J. (Rutgers–The State Univ., New Brunswick, N. J. Dept. of Physics). Mar 1972.

From Joint Japanese–U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

The current Rutgers–Stevens bubble chamber research program is described, and some general comments are made on bubble chamber physics. The research is being carried out on baryon interactions with baryons. (J.F.P.)

41784 MEASUREMENT OF THE TOTAL CROSS-SECTIONS FOR Λ HYPERON INTERACTIONS ON PROTONS AND NEUTRONS IN THE MOMENTUM RANGE FROM 6 GeV/c TO 21 GeV/c. Gjesdal, S. (CERN, Geneva); Presser, G.; Steffen, P.; (and others). Phys. Lett.; 40B: No. 1, 152-6(12 Jun 1972).

The Λp, Λn, $\bar{\Lambda}p$, and $\bar{\Lambda}n$ total cross sections were measured in the Λ momentum interval 6-21 GeV/c. Within the experimental uncertainties the cross sections are momentum-independent in this interval and the momentum-averaged cross sections are found to be: $\sigma(\Lambda p) = 34.6 \pm 0.4$ mb; $\sigma(\Lambda n) = 34.0 \pm 0.8$ mb; $\sigma(\bar{\Lambda}p) = 56 \pm 11$ mb; $\sigma(\bar{\Lambda}n) = 46 \pm 20$ mb. The first two results are in agreement with charge symmetry, and with simple quark model sum rules applied to previous results on pp, K^-n, and π^+p total cross-sections. (auth)

41785 PARTICLE PRODUCTION RATIOS AT 21, 31, 45, AND 53 GeV IN THE CENTRE OF MASS. Albrow, M. G.; Barber, D. P.; Bogaerts, A.; (and others) (CERN, Geneva. Foundation for Fundamental Research on Matter, Utrecht. Univ. of Lancaster, Eng. Univ. of Manchester, Eng.). Phys. Lett.; 40B: No. 1, 136-40(12 Jun 1972).

Particle production ratios were measured for $\pi^\pm$, $K^\pm$, p and $\bar{p}$ at the CERN ISR. (auth)

41786 TRANSVERSE AND LONGITUDINAL MOMENTUM SPECTRA OF PIONS IN $\bar{p}d$ INTERACTIONS AT 3.5 GeV/c. Ijaz, M. A. (Virginia Polytechnic Inst. and State Univ., Blacksburg); Munir, B. A.; Terrault, E. J. B. Nucl. Phys.; B42: 85-94(1 Jun 1972).

Experimental p_t and p_l spectra of pions in 3, 4, 5 and 6 prong events in $\bar{p}d$ reactions at 3.5 GeV/c were measured in a bubble chamber experiment. The p_t spectra are fitted with Hagedorn and Boltzmann distributions. The average value of p_t is found to be in the range of 0.35 to 0.40 GeV/c. The p_t spectra of annihilation pions are fitted better with the above distributions than the spectra of pions found in production reactions. The c.m.s. p_l spectra of pions are analyzed in terms of Jacob's nova model and Feynman's scaling distribution. The p_l spectra, when analyzed after making cuts in p_t distributions, reveal that p_l and p_t are not independent of each other in this experiment. (auth)

41787 ANTIPROTON PROTON ANNIHILATIONS AT 1.6 TO 2.2 GeV/c INTO FINAL STATES WITH K_1^0 MESON. Chapman, J. W.; Church, T. M.; Lys, J.; (and others) (Univ. of Michigan, Ann Arbor). Nucl. Phys.; B42: 1-28(1 Jun 1972).

Antiproton proton annihilations into final states containing at least one K_1^0 meson were studied in a 150,000-picture bubble chamber experiment. The experiment covered six incident antiproton momenta in the range 1.6 to 2.2 GeV/c. Cross sections at each incident momentum are determined for the more abundantly produced final states, and momentum averaged cross sections are determined for some rarer final states, including $K^0\overline{K^0}$ and $K^0\overline{K^0}K^+K^-$. Copious resonance production, including double resonance production, is observed, and percentage contributions of different resonance channels are evaluated. Cross sections and resonance fractions are compared with results of other experiments at antiproton momenta in the range 0.7 to 3.7 GeV/c. (auth)

41788 DETERMINATION OF THE PARTIAL COEFFICIENT OF INELASTICITY K_{π^0} IN THE ENERGY RANGE E_0 = 100 TO 1500 GeV. Fetisov, I. N. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2187-94(Oct 1971). (In Russian).

Proton and neutron interactions were studied using targets of LiH (light nuclei) and Cu + Pb (heavy nuclei), and the partial coefficient of elasticity K_{π^0} was computed from these data. In the energy range 100 to 500 GeV, $K_{\pi^0} = 0.15 \pm 0.04$ for LiH. In the target characterized by 70% interaction in Pb and 30% in Cu, values of K_{π^0} were: 0.19 ± 0.03 for 100 to 300 GeV, 0.17 ± 0.02 for 300 to 600 GeV, and 0.16 ± 0.03 for 600 to 1,400 GeV. (K.S.W.)

41789 SEARCH FOR HEAVY NONRELATIVISTIC PARTICLES IN COSMIC RADIATION AT SEA LEVEL. Gal'per, A. M.; Gomozov, V. A.; Kirillov-Ugryumov, V. G.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2092-7(Oct 1971). (In Russian).

The upper limit of the flux of particles at sea level characterized by a mass greater than that of two protons, a velocity less than 0.67 c, and unit charge, was found to be 3.2×10^{-6} $\mathrm{sec^{-1} \cdot cm^{-2} \cdot ster^{-1}}$, not allowing for absorption in the material of the apparatus. (tr-auth)

41790 TRACKING HADRONS BY ELECTRON–PHOTON SHOWERS IN THE ATMOSPHERE. Sokolovskii, V. I. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2123-7(Oct 1971). (In Russian).

The high-altitude station Tyan'-Shan' (3,300 m) was selected as the site for tracking hadrons with atmospheric electron-photon showers, using an ionization calorimeter. The distribution of showers was studied with respect to the number of particles which accompanied the nuclear-active particle with energies of 1.3×10^{12} to 10^{13} eV. (K.S.W.)

41791 MULTIPLE-PARTICLE PRODUCTION DURING INTERACTION OF HADRONS WITH ALUMINUM NUCLEI IN THE ENERGY RANGE 50 TO 250 GeV. Alakoz, A. V.; Vasil'eva, L. F.; Vasil'ev, P. S.; Lakaev, V. S.; Shmeleva, A. P. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2073-5(Oct 1971). (In Russian).

The distribution of secondary charged particles was obtained in accordance with the multiplicity and angle at primary energies of 55 and 250 GeV. The dependence of the average multiplicity of secondary charged particles on the number of nucleons in the nucleus is in harmony with the law: $\bar{n}_s \sim A^\alpha$, where $\alpha = 0.1 \pm 0.02$. (tr-auth)

41792 CROSS SECTION OF PIONIZATION OF CARBON NUCLEI BY HADRONS OF ENERGY 100 TO 300 GeV. Alakoz, A. V.; Vasil'ev, P. S.; Vasil'eva, L. F.; Shmeleva, A. P. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2069-72(Oct 1971). (In Russian).

An increase in the pionization cross section with an increase in energy was not observed within the limits of experimental error during hadron interaction with carbon nuclei in the energy range from 20 to 300 GeV. (tr-auth)

41793 EMISSION CHARACTERISTICS IN INELASTIC INTERACTIONS OF PARTICLES OF COSMIC RADIATION IN THE ENERGY RANGE 10^{11} TO 10^{12} eV. Abdullaev, A. M.; Azimov, S. A.; Beisembaev, R. U.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2065-8(Oct 1971). (In Russian).

An arrangement for studying the interaction of nuclear-active components of cosmic rays with $E > 10^{11}$ eV is described. Data which express the transmission of energy to neutral pions are given. Nuclear disintegration was studied with a Cherenkov spectrometer. (tr-auth)

41794 MEASUREMENT OF THE COEFFICIENT OF INELASTICITY K_{π^0} FOR INTERACTIONS OF NUCLEONS WITH CARBON. Babayan, Kh. P.; Boyadzhyan, N. G.; Mamidzhanyan, E. A. (Inst. of Physics, Erevan). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2064(Oct 1971). (In Russian).

Values of the inelasticity coefficient ($K_{\pi^0} = E_{\pi^0}/E_0$) for interaction in carbon are tabulated for a range of energies, E_0, from 300 to 5,000 GeV. The distribution of K_{π^0} for the interaction of neutrons ($E_0 > 500$ GeV) in graphite is graphically depicted. (K.S.W.)

41795 ENERGY TRANSFER TO THE ELECTRON–PROTON COMPONENT DURING INTERACTION OF HADRONS OF VARIOUS ENERGIES WITH LEAD NUCLEI. Nam, R. A.; Nikol'skii, S. I.; Pavlyuchenko, V. P.; Yakovlev, V. I. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2059-63(Oct 1971). (In Russian).

Using an ionization calorimeter the fraction of energy transmitted to γ quanta during hadron interaction with lead was determined to be: $K_\gamma = 0.25 \pm 0.02$ in the energy range $E_0 < 5$ TeV, and $K_\gamma = 0.34 \pm 0.35$ for $E_0 > 10$ TeV. The mean range for absorption of a nuclear shower in lead falls from 500 ± 30 $\mathrm{g \cdot cm^{-2}}$ for $E_0 = 2$ TeV to 310 ± 20 $\mathrm{g \cdot cm^{-2}}$ for $E_0 > 10$ TeV. Explanations of the observed effects are advanced. (tr-auth)

41796 INVESTIGATION OF THE INTERACTIONS OF HIGH-ENERGY COSMIC PARTICLES AT THE MOUNT ARAGATS INSTALLATION. Anoshin, A. I.; Bashindzhagyan, G. L.; Dem'yanov, A. I.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2054-8(Oct 1971). (In Russian).

The device "Pion" was assembled at the Aragats station at an altitude of 3,260 m for the purpose of studying high energy interaction of pions and nucleons with atomic nuclei in the energy range 100 to 1,000 GeV. The intensity of electrons and protons with $E > 150$ GeV was equal to $(5.0 \pm 2) \times 10^{-6}$ $\mathrm{cm^{-2} \cdot sec^{-1} \cdot ster^{-1}}$. The intensity of nuclear-active particles with $E > 450$ GeV equaled $(6.6 \pm 2) \times 10^{-6}$ $\mathrm{\cdot cm^{-2} \cdot ster^{-1}}$. The mean free path of interaction of nuclear-active particles with energies >200 GeV in graphite, iron, and lead were, respectively: 90 ± 18, 143 ± 10, and 196 ± 40 $\mathrm{g \cdot cm^{-2}}$. The partial coefficient of inelasticity $\alpha_\gamma(\mathrm{Pb}) = 0.28 \pm 0.04$. (K.S.W.)

41797 PROPERTIES OF INELASTIC INTERACTION OF NUCLEAR-ACTIVE PARTICLES WITH ENERGY OF $\sim 5 \times 10^{11}$ eV. Berdzenishvili, O. L.; Gabuniya, L. L.; Garibashvili, D. I.;

(and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2029-32(Oct 1971). (In Russian).

A 1,000-liter Wilson chamber and an ionization calorimeter were utilized in a study of the multiplicity and energy characteristics of secondary particles possessing energies of the order of 5×10^{11} eV. The distributions of longitudinal and transverse momenta are discussed. (K.S.W.)

41798 MULTIPLE PRODUCTION OF PARTICLES IN NUCLEON–NUCLEON COLLISIONS WITH AN AVERAGE ENERGY OF 250 GeV. **Akimov, V. N.; Guseva, V. V.; Denisova, V. G.; (and others) (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2017-21(Oct 1971). (In Russian).**

Experimental data on the multiple production of mesons in the energy range of 250 GeV are given. A comparison of such data with calculated values shows that in about 40% of the events there are formed heavy meson clusters with masses of about 4 GeV (fireball), decaying in conformity with statistical theory. (tr-auth)

41799 REAL PART OF THE AMPLITUDE OF PROTON–DEUTERON SCATTERING AT AN ENERGY 3 GeV. **Korbel, Z.; Rob, L. (Charles Univ., Prague). Czech. J. Phys.; 22: No. 4, 326-8(1972).**

Measurement of the differential cross sections of the proton–deuteron scattering at 3 GeV is described. The measurement was performed in the region of angles 2.5 to 11.5°. Analysis of the experimental data shows that besides the imaginary scattering amplitude a real part of the scattering amplitude is also required to describe proton–deuteron scattering at 3 GeV energy; the magnitude of the real part is 28% of the imaginary part. (auth)

41800 NEUTRON–PROTON CHARGE-EXCHANGE SCATTERING FROM 8 TO 29 GeV/c. Davis, Michael B. (Princeton Univ., N. J.); Gibbard, Bruce G.; Kreisler, Michael N.; (and others). Phys. Rev. Lett.; 29: No. 2, 139-42(10 Jul 1972).

Differential cross sections are presented for neutron-proton charge-exchange scattering from 8 to 29 GeV/c. The data, based on ~23,000 events, extend to four-momentum transfers $|u|$ as large as 1.0 $(\mathrm{GeV/c})^2$. The shape of the differential cross sections and the momentum dependence are examined in detail. (auth)

41801 STUDY OF THE 1500 AND 1700 MeV ENHANCEMENTS IN THE $p\pi^+\pi^-$ MASS IN THE REACTION $pp \to pp\pi^+\pi^-$ AT 19 GeV/c. Johnstad, H. (Univ., Copenhagen); Moellerud, R.; Veje, L.; (and others). Nucl. Phys.; B42: 558-72(1 Jun 1972).

The 1500 MeV and 1700 MeV enhancements observed in the $p\pi\pi$ system are analyzed. It is found that the 1500 MeV effect is not a pure angular momentum state. Neither t- nor s-channel helicity is conserved. The 1700 MeV effect gives good fits to $J = 3/2$ and $5/2$ decaying to $p\pi\pi$. In the decay mode $\Delta^{++}\pi^-$ $J = 5/2$ is preferred over $3/2$. Moment analysis shows consistency with t- rather than s-channel helicity conservation. (auth)

41802 DIFFRACTION PROCESSES. **Trilling, George H. (Univ. of California, Berkeley). pp 326-74 of Proceedings of the Fourth Hawaii Topical Conference in Particle Physics. /Yount, D. E. (ed.). Honolulu, Hawaii; Univ. of Hawaii Press (1972).**

From fourth topical conference in particle physics; Honolulu, HI. (2 Aug 1971). See CONF-710819.

A review is given of a class of elastic and inelastic processes characterized by sharply peripheral behavior and by a close relation between the quantum numbers of the incident particle and those of the outgoing particles. Only processes involving single-nucleon targets are considered. Some general aspects of the diffractive part of elastic scattering are discussed emphasizing recent results, then diffractive dissociation of both incident nucleons and incident bosons are treated. (J.F.P.)

41803 EXPERIMENTAL ASPECTS OF MULTIPARTICLE PHENOMENA. **Trilling, George H. (Univ. of California, Berkeley). pp 465-93 of Proceedings of the Fourth Hawaii Topical Conference in Particle Physics. /Yount, D. E. (ed.). Honolulu, Hawaii; Univ. of Hawaii Press (1972).**

From fourth topical conference in particle physics; Honolulu, HI. (2 Aug 1971). See CONF-710819.

The present experimental status of multiparticle phenomena in strong interactions is discussed giving emphasis to actual experimental data. High-energy cross sections and multiplicity, a simple example of multiparticle production, energy dependence of secondary spectra, forward–backward asymmetries for nonleading secondaries, scaling, and factorization are covered. (J.F.P.)

Strong (Meson-induced)

Refer also to abstract 41976.

41804 (BNL–16908) DETERMINATION OF η' PARAMETERS FROM THE REACTION $K^-p \to \Lambda\eta'$ AT 2.2 GeV/c. Danburg, Jerome S.; Borenstein, Samuel R.; Kalbfleisch, George R.; Strand, Richard C.; VanderBurg, Vance D. (Brookhaven National Lab., Upton, N. Y.); Chapman, J. W.; Kiang, Richard K. (Michigan Univ., Ann Arbor. Dept. of Physics). 1972. 18p. (CONF-720409–2). Dep. NTIS.

From Conference on meson spectroscopy; Philadelphia, PA. (28 Apr 1972).

New data are presented on the η' based on a sample of events obtained from 870,000 pictures of the BNL 31-inch hydrogen bubble chamber exposed to a 2.2 GeV/c K^- beam. The η' mass, width, and branching ratios were measured, and strong evidence is presented that the quantum numbers of the η' are $J^{PC} = 0^{\pm}$. (auth)

41805 (COO–1112-28) STUDY OF THE REACTION $\pi^-p \to \pi^{\mp}N^*_{1236}$ NEAR 180° FROM 2.15 TO 6.0 GeV/c. Rice, James Eugene (Michigan Univ., Ann Arbor). 1970. 174p. Dep. NTIS.

Thesis.

The execution, analysis, and the results of a missing mass optical spark chamber experiment which investigated the general features of the reaction $\pi^-p \to \pi^{\pm}$ (anything) near 180° are described. Data were taken at 11 beam momenta from 2.15 to 6.0 GeV/c and later combined into four beam momentum ranges. In order to study possible N* resonance production, missing mass plots were made. These missing mass plots show little structure except in the N^*_{1236} region. The N^{*+}_{1236} cross section is consistent with being zero everywhere in this energy range. The N^{*-}_{1236} cross section exhibits a sharp dip at 180° in each of the four beam momentum ranges. This dip seems to be a result of strong production of the helicity $3/2$ state for the N*. The cross section for N^{*-}_{1236} production is inconsistent with the quark model prediction of Bialas et al. (auth)

41806 (COO–1195-237) NEW MEASUREMENT OF THE $\omega(784)$ WIDTH. Brown, R. M.; Downing, R. W. (Illinois Univ., Urbana. Dept. of Physics); Bernstein, S.; (and others) (Illinois Univ., Chicago. Dept. of Physics). May 1972. Contract AT(11-1)-1195. 11p. Dep. NTIS.

A measurement of the $\omega(784)$ decay width was performed using a neutron counter missing-mass spectrometer. A value of $\Gamma_\omega = (7.7 \pm 1.0)$ MeV is obtained. The quoted error does not include systematic errors of ±0.3, ±0.2 and ±0.15 MeV due to uncertainties in background, angular resolution, and beam momentum resolution, respectively. The value of Γ_ω is significantly lower than the current world average of $\Gamma_\omega = (10.0 \pm 0.6)$ MeV. (auth)

41807 (JINR–E1-6327) COMPILATION OF CROSS SECTIONS FOR STRANGE PARTICLE PRODUCTION IN π^-p INTERACTIONS. Berceanu, I.; Berceanu, S.; Besliu, T.; Mihul, A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1972. 143p. Dep. NTIS (U.S. Sales Only).

A compilation of cross sections for strange particle production in the interactions of negative pions with protons is presented. Graphs of the variation of cross section with incident laboratory momentum are given. (auth)

41808 (SLAC–144, pp 4.1-10) THOUGHTS ON THE LIMITATIONS OF PRESENT BUBBLE CHAMBER EXPERIMENTS. **Flatte, Stanley M. (California Univ., Berkeley. Lawrence Radiation Lab.). Mar 1972.**

From Joint Japanese–U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

A discussion is given of the accomplishments of bubble chambers in the recent past and the prospects for these same bubble chambers (mainly hydrogen bubble chambers up to 2m in length). The research discussed is primarily the A_2 structure and diffraction studies. (J.F.P.)

41809 (SLAC–144, pp 5.1-24) π–p INTERACTIONS AS MEASURED BY PEPR. Pless, I. A. (Massachusetts Inst. of Tech., Cambridge). Mar 1972.

From Joint Japanese–U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

A progress report on PEPR is given. A new technique useful in analyzing multibody final states is outlined, and application of this new technique to $\pi + p$ interactions at 3.9 and 5.8 GeV/c is discussed. Possible practical applications of PEPR are considered. (C.E.S.)

41810 (SLAC–144, pp 7.1-18) N–η RESONANCES. Kitagaki, T. (Tohoku Univ., Sendai (Japan)). Mar 1972.

From Joint Japanese–U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

Preliminary results on the N–η system studied in the reactions $\bar{p} + p \rightarrow \bar{p} + p + \eta$ at 6.95 GeV/c and $\pi^- + p \rightarrow \pi^- + p + \eta$ at 7.85 GeV/c in a bubble chamber are given. Momentum and mass distributions are given for the pη system. An analysis of peaks in the pη mass plot gives a possible correspondence to S_{11}(1535), P_{11}(1780), and P_{13}(1860). (J.F.P.)

41811 (SLAC–144, pp 8.1-26) $\pi^-p \rightarrow \pi\pi N$ REACTIONS AT 8 GeV/c. Takahashi, Kasuke (Tohoku Univ., Sendai (Japan)). Mar 1972.

From Joint Japanese–U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

A study of $\pi^-p \rightarrow \pi\pi N$ at 8 GeV/c was made by analyzing the combined data consisting of 3229 events of $\pi^-p \rightarrow \pi^-\pi^+n$ and 1496 events of $\pi^-\pi^0p$ final state. The data are based on separate measurements carried out at the University of Pennsylvania, University of Notre Dame, and Tohoku University. Analysis of the $(\pi^-\pi^+)$ dipion system gives evidence of a possible new resonance of mass (2080 ± 20) MeV with a width $\Gamma = 160 \pm 20$ MeV. The possible isospin of the resonance is I = 1, and its angular momentum quantum number may be either 1^-, 3^-, or 5^-. Extensive studies of production angular distributions at very small momentum transfer squared and decay angular distributions are made for ρ^0 and f^0 mesons. Comparison of the results for ρ^0 with the vector dominance model (VDM) predictions have shown a reasonable agreement. (auth)

41812 (SLAC–144, pp 13.1-45) DIFFRACTION PRODUCTION OF BOSONS. Ferbel, T. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). Mar 1972.

From Joint Japanese–U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

Recent results obtained in the analysis of diffractively produced multimeson systems are summarized, and speculation is made on the mechanism responsible for these production processes. (auth)

41813 (SLAC–144, pp 15.1-20) MULTIPLE PARTICLE PRODUCTION IN 12.6 GeV/c K^-p REACTIONS. Teranaka, M.; Konishi, S.; Konishi, T.; Kusumoto, O.; Ochiai, F.; Okabe, H.; Ozaki, S.; Ushida, N.; Yokota, J. (Osaka City Univ. (Japan)). Mar 1972.

From Joint Japanese–U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

The reactions $K^- + p \rightarrow K_1^0(\Lambda)$ + anything at 12.6 GeV/c in a hydrogen bubble chamber were studied and the cross sections and momentum distributions were found. The momentum distributions for the $K_1^0 + p + m\pi$ channels were also plotted. (J.F.P.)

41814 (SLAC–144, pp 16.1-11) MULTIPARTICLE PRODUCTION AT 12 GeV/c. Peters, M. W. (Hawaii Univ., Honolulu). Mar 1972.

From Joint Japanese–U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

The cross sections and mass distributions for $\pi^- + p \rightarrow p + m\pi$ interactions at 12 GeV/c in a hydrogen bubble chamber are studied. A possible negative-G-parity enhancement U^-(2400) decaying into $2\mu^0 + \pi^-$ is found, and its branching ratio obtained. (J.F.P.)

41815 (SLAC–144, pp 18.1-39) K_L^0p INTERACTIONS FROM 1 TO 10 GeV/c. Loos, J. S. (Stanford Linear Accelerator Center, Calif.). Mar 1972.

From Joint Japanese–U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

A progress report is presented on $K_2^0 + p$ interactions at 1 to 10 GeV/c in a hydrogen bubble chamber. Cross sections for the reactions $K_2^0 + p \rightarrow K_1^0 + p$, $\bar{K}^0 + p \rightarrow \pi^+ + \Lambda$, $K^0 + p \rightarrow K^+ + p + \pi^-$, $\bar{K}^0 + K^- + \pi^+ + p$, and preliminary results on Q^0 and $\bar{Q}^0$ production in $K_2^0 + p \rightarrow K_1^0 + p + \pi^+ + \pi^-$ interactions are discussed. (J.F.P.)

41816 MISSING-MASS SPECTRA OBSERVED IN $\pi^- + p \rightarrow p + X^-$ AT 25 AND 40 GeV/c. Antipov, Y. M.; Baud, R.; Busnello, R.; (and others) (CERN, Geneva. Inst. of High-Energy Physics, Serpukhov, USSR. European Organization for Nuclear Research, Geneva). Phys. Lett.; 40B: No. 1, 147-51(12 Jun 1972).

Missing-mass spectra were obtained in the reaction $\pi^-p \rightarrow pX^-$ at 25 and 40 GeV/c at the Serpukhov Accelerator. At low masses a strong peak at 1.3 and a smaller one near 1.7 GeV are observed. In the mass region above 2 GeV no structure exceeding 3μb/(GeV/c)^2 is seen. (auth)

41817 K^+p ELASTIC SCATTERING BETWEEN 2.11 AND 2.72 GeV/c. Danysz, J. A. (Imperial Coll. of Science and Tech., London); Penney, B. K.; Stewart, B. C.; (and others). Nucl. Phys.; B42: 29-43(1 Jun 1972).

Final results are presented of the analysis of the elastic channel in an exposure of 40,000 pictures at each of the four incident K^+ momenta 2.11, 2.31, 2.53 and 2.72 GeV/c taken in the 1.5 m British National Hydrogen Bubble Chamber at the 8 GeV/c proton synchrotron at the Rutherford High Energy Laboratory. Differential cross sections are presented and the results are compared with other published data. A Legendre polynomial analysis requires partial waves up to G wave at all momenta. For the backward peak, visible at each momentum, the slope and the intercept are calculated. A comparison of the forward peak is made with extrapolations from Regge models fitted at higher momenta. (auth)

41818 RELATION BETWEEN THE GGLP EFFECT AND MASS DISTRIBUTION FOR PARTICLE PAIRS. Eskreys, A. (Inst. of Nuclear Physics, Krakow); Figiel, J.; Malecki, P.; (and others). Nucl. Phys.; B42: 44-55(1 Jun 1972).

Data on the GGLP effect in the reactions $K^+p \rightarrow K^02\pi^+\pi^-p$, $K^+p \rightarrow K^+2\pi^+2\pi^-p$, $K^+p \rightarrow K^03\pi^+2\pi^-p$, at 8.25 GeV/c kaon incident momentum are presented. Some indication of a similar effect for $(K\pi)$ pairs is noted. A test is devised to check the conjecture that the GGLP effect in a channel is a reflection of the difference between the corresponding two-particle effective mass distributions. The test is applied to the second reaction and the conjecture is proved to be true in this case. (auth)

41819 EXPERIMENTAL STUDY OF THE REACTION $\pi^-p \rightarrow \pi^0\pi^0n$ AT 447 MeV INCIDENT PION ENERGY. Bunyatov, S. (Joint Inst. for Nuclear Research, Dubna, USSR); Kurbatov, V.; Zavattini, E.; (and others). Nucl. Phys.; B42: 77-84(1 Jun 1972).

Differential cross sections for the neutrons resulting from the reaction $\pi^-p \rightarrow \pi^0\pi^0n$ at 447 MeV were measured for angles ranging from 20 to 60° in the lab system. The experimental missing-mass spectrum has a noticeable enhancement over the phase space distribution in the region of large masses, and some excess in the region of small masses. The angular distribution for neutrons in the c.m.s. has a sharp asymmetry with a predominant backward production of neutrons. The total cross section of the reaction $\pi^-p \rightarrow \pi^0\pi^0n$ at 447 MeV is found to be 1.90 ± 0.25 mb. (auth)

41820 STUDY OF $K\pi$ INELASTIC SCATTERING BY THE CHEW–LOW EXTRAPOLATION METHOD. Mettel, D. (LPNHE, Paris). Nucl. Phys.; B42: 340-8(1 Jun 1972).

The cross section for the reaction $K^+\pi^- \rightarrow K^0\pi^+\pi^-$ was determined using the Chew–Low extrapolation method for events where the $(K\pi\pi)$ system is produced in association with a Δ^{++}. The analysis is based on 3108 events belonging to the reaction $K^+p \rightarrow K^0\pi^+\pi^-\pi^+p$ at 5 and 8.25 GeV/c, obtained in bubble chamber exposures at CERN. The dependance of the cross section upon the $(K^0\pi^+\pi^-)$ mass between 1.2 and 1.6 GeV may be explained by the formation of the K^{**} (1420) resonant state. (auth)

41821 MULTIPLICITY DISTRIBUTIONS AND CORRELATIONS IN INCLUSIVE PROCESSES. Bialas, A.; (Jagellonian Univ., Krakow. Inst. of Nuclear Physics, Krakow); Zalewski, K. Nucl. Phys.; B42: 325-32(1 Jun 1972).

The correlation parameters for the negative pions produced in pp and π^-p collisions are calculated from the available multiplicity distributions. The predictions of several theoretical models are compared with the data. (auth)

41822 NEGATIVE-KAON–HYDROGEN CHARGE-EXCHANGE SCATTERING AT 1.8 GeV/c. Sossong, Norman D. (Univ. of Washington, Seattle); Ellsworth, Robert; Carlson, James R.; Davis, Howard F.; Jauch, Delbert E. Phys. Rev., D; 5: No. 11, 2711-20 (1 Jun 1972).

An experiment measuring the differential cross section for K^-p charge-exchange scattering was done at 1.8 GeV/c. The results of the neutral-trigger spark-chamber detection scheme gave 2610 events with neutral mass range 900 to 1700 MeV. The results were fitted to Legendre polynomials to order 7 for $d\sigma/d\Omega$. The results are significant to order 6 for $d\sigma/d\Omega(K^-p \rightarrow \bar{K}^0n) = \Sigma_n a_n P_n(\cos\theta^*)$; $a_0 = 52 \pm 6$, $a_1 = 112 \pm 14$, $a_2 = 122 \pm 23$, $a_3 = 106 \pm 22$, $a_4 = 84 \pm 26$, $a_5 = 59 \pm 18$, $a_6 = 26 \pm 19$. Earlier data show a dip in the forward $d\sigma/d\Omega$; no such dip is evident from the data of this experiment. The results of this experiment in the forward direction are not inconsistent with an absorption-model modified ρ-exchange mechanism for the charge-exchange process. (auth)

41823 π^-p ELASTIC SCATTERING AT 2.29 GeV/c. Hagopian, S. (Florida State Univ., Tallahassee); Hagopian, V.; Bogart, E.; O'Donnell, R.; Selove, W. Phys. Rev., D; 5: No. 11, 2684-8(1 Jun 1972).

The reaction $\pi^- + p \rightarrow \pi^- + p$ was studied in the 15-in. bubble chamber at the Princeton-Pennsylvania Accelerator. The elastic scattering cross section was determined to be 8.5 ± 0.2 mb. The forward peak fits to an exponential in t with a slope of 8.1 ± 0.2 $(GeV/c)^{-2}$. The forward differential cross section $d\sigma/d\Omega(0) = 17.9 \pm 0.7$ mb/sr. A fit of the center-of-mass angular distribution to Legendre polynomials needed terms up to the 12th order, corresponding to the highest nonzero partial wave of $L = 6$. (auth)

41824 SEARCH FOR A WEAKLY DECAYING $S = +2$ EXOTIC MESON. Young, L. (California Inst. of Tech., Pasadena); Barish, B.; Loken, S.; Sciulli, F.; Davies, D. Phys. Rev., D; 5: No. 11, 2727-9(1 Jun 1972).

A search for a strangeness-2 exotic meson (X^+) with mass less than two kaon masses has resulted in a limit on the cross section for the production of this particle in the reaction $K^+ + n \rightarrow \Lambda^0 + X^+$. For 1.9-GeV/c incident K^+'s, this cross section is less than 3.3 μb with 90% confidence. The known cross section for the analogous reaction $\pi^+ + n \rightarrow \Lambda^0 + K^+$ is about 170 μb at this energy, or more than 50 times larger. (auth)

41825 EVIDENCE FOR COHERENT A_2 PRODUCTION OFF DEUTERIUM. Harrison, D. (Univ. of Toronto); Prentice, J. D.; West, E. C.; (and others). Phys. Rev., D; 5: No. 11, 2730-2(1 Jun 1972).

Evidence is presented for coherent production of A_2^+ off deuterium at an incident π^+ momentum of 6.95 GeV/c. The data are taken from a 650 000-picture exposure of the 30-in. deuterium-filled MURA-ANL bubble chamber at Argonne National Laboratory. The A_2 signal is greatly enhanced by weighting the events with Zemach matrix elements for 2^+ $\rho^0\pi^+$ decays. The cross section of 10 μb is well matched by a calculation using the cross section for production of the isoscalar A_2 off single nucleons and the deuterium form factor. (auth)

41826 INVESTIGATION OF LOW-MASS $K\pi\pi$ SYSTEMS IN 12-GeV/c K^+p INTERACTIONS. Davis, Philip J.; Alston-Garnjost, Margaret; Barbaro-Galtieri, Angela; (and others) (Univ. of California, Berkeley). Phys. Rev., D; 5: No. 11, 2688-2710 (1 Jun 1972).

The broad $K\pi\pi$ mass enhancements at 1300 MeV were studied in the reactions $K^+p \rightarrow pK^+\pi^-\pi^+$ and $pK^0\pi^0\pi^+$ at 12 GeV/c. The data were obtained from a 600 000-picture exposure of the SLAC 82 in. hydrogen bubble chamber (which corresponds to a path length of 35 events/μb). A two-peak substructure was observed in the $K^0\pi^0\pi^+$ mass spectrum at 1260 and 1420 MeV. The estimated contribution of the $K_N(1420)$ accounts for only about half of the 1420-MeV peak (a discrepancy of about 2.4 standard deviations). The $K^+\pi^-\pi^+$ mass spectrum has a different shape. Further, assuming the $K\pi\pi$ system to be S wave 1^+ $K_V(890)\pi$ and $\rho(765)K$, the $K^+\pi^-\pi^+$ and the $K^0\pi^0\pi^+$ Dalitz plots were fitted separately. Inconsistent fits were obtained. This inconsistency and the differences in the $K\pi\pi$ mass spectra could be explained by an additional contribution of an $I = 0$ S-wave $\pi\pi$ state in $K^+\pi^-\pi^+$. The $K\pi\pi$ angular decay distributions imply the dominance of the spin-parity state 1^+ with $M_z = 0$ along the incident beam direction. However, there are other J^P states and states with $M_z \neq 0$. The 1260-MeV $K\pi\pi$ mass region is produced more peripherally than the 1420-MeV region. (auth)

41827 $A_3(f\pi)$ SPIN–PARITY ANALYSIS. Armenise, N. (Univ., Bari, Italy. Istituto Nazionale di Fisica Nucleare, Bari, Italy); Fogli Muciaccia, M. T.; Picciarelli, V.; (and others). Lett. Nuovo Cim.; 4: No. 6, 201-4(10 Jun 1972).

The reaction $\pi^- + p \rightarrow p + \pi^+ + 2\pi^-$ at 9.1 GeV/c in a hydrogen bubble chamber was studied for the A_3 spin–parity analysis. The cross section for this reaction was found to be 1140 ± 100. Other resonance production included the $\Delta^{++}(1236)$, A_1, A_2, ρ^0, and f. Both the multiple-moments and the Dalitz-plot analyses yielded a value of 2^- for the A_3 spin–parity. (J.F.P.)

41828 SOME RESULTS ON THE ρ (1.71) RESONANCE PRODUCED IN 9.1 GeV/c π^-p COLLISIONS. Armenise, N. (Univ., Bari, Italy); Fogli Muciaccia, M. T.; Picciarelli, V.; (and others). Lett. Nuovo Cim.; 4: No. 6, 205-9(10 Jun 1972).

The decay of the $\rho(1710)$ resonance produced in $\pi^- + p \rightarrow p + \pi^+ + 2\pi^- + \pi^0$ interactions at 9.1 GeV/c in hydrogen bubble chamber is studied. Cross sections for this reaction and the production of Δ^{++} (1236), ρ, η, ω, A_2^-, A_2^+, and B are also found. The mass, width, and cross section for production of the $\rho(1710)$ are evaluated. It is concluded that the majority of the peak comes from the $p\rho^0\rho^-$ channel of the $\rho(1710)$ resonance. (J.F.P.)

41829 ENERGY CHARACTERISTICS OF SECONDARY PARTICLES IN πN AND COHERENT INTERACTIONS AT 60 GeV/c. Zhdanov, G. B.; Maslennikova, N. V.; Miroshnichenko, L. N.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2076-9(Oct 1971). (In Russian).

The πN interactions were selected according to the criterion $N_h \leq 3$, and momenta measurements were conducted on the secondary particles with initial momenta of 60 GeV/c. An anomaly of the momentum spectrum of fast particles of the forward cone as compared with the corresponding pion spectrum may be explained by a significant number of cases of an energetically released charged pion. Correlations between longitudinal and transverse particle momenta, and the distribution of coefficients of inelasticity are discussed. (K.S.W.)

41830 ANALYSIS OF PION–NUCLEON INTERACTIONS AT $E_0 = 60$ GeV WITH SLOW PROTON RECOIL. Vinitskii, A. Kh.; Takibaev, Zh. S.; Shakhova, Ts. I. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2080-2(Oct 1971). (In Russian).

In pion-nucleon interactions in nuclear emulsion with an identified proton, the fireball mass was determined according to the recoil nucleon and the π-meson released. These particles do not participate in the formation of π-mesons on account of the decay of the fireball. The spectrum of effective masses found in this way are compared with the theoretical predictions. (tr-auth)

41831 COEFFICIENT OF INELASTICITY OF PION–NUCLEON INTERACTIONS. Gaitinov, A. Sh.; Takibaev, Zh. S.; Chasnikov, I. Ya. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2083-7 (Oct 1971). (In Russian).

The distribution of the inelasticity coefficients of pion-nucleon interactions are given for a momentum of 10.2 GeV/c. The fraction of the total energy going into the formation of new particles is 0.40 ± 0.02, of which 0.13 ± 0.01 go into the formation of neutral pions. The fraction of energy removed by one pion mildly decreases with an increase in the number of particles generated, and is not different from corresponding values for proton–proton interaction. (tr-auth)

41832 INTERACTION OF NUCLEAR-ACTIVE PARTICLES WITH ENERGIES OF 10^{11} TO 10^{12} eV USING AN IONIZATION CALORIMETER. Berdzenishvili, O. L.; Garibashvili, D. I.; Gromov, Yu. A.; (and others) (Inst. of Physics, Tbilisi, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2033-5(Oct 1971). (In Russian).

The cross section of inelastic interaction and the partial coefficient of inelasticity were investigated with an ionization chamber for hadrons of cosmic rays with energies of ~100 GeV. Averaged nuclear cascade curves showing the interaction in lead of primary nucleons and pions at energies above and below 300 GeV are given. The partial coefficient of inelasticity for 33 π Pb-interactions with $\bar{\bar{E}} = 400$ GeV was 0.2 ± 0.1. (K.S.W.)

41833 DIFFERENTIAL CROSS SECTIONS FOR ELASTIC SCATTERING OF POSITIVE KAONS ON PROTONS IN THE MOMENTUM RANGE 0.9 to 1.9 GeV/c. Charles, B. J. (Univ. of Bristol, Eng.); Cowan, I. M.; Edwards, T. R.; (and others). Phys. Lett.; 40B: No. 2, 289-92(26 Jun 1972).

Measurements are reported of differential cross sections for K^+p elastic scattering at 17 momenta in the 0.9- to 1.9-GeV/c range. The angular range was covered by two independent configurations of acoustic spark chambers as the particle detectors. The total elastic cross section was also determined. A preliminary comparison is made of the new data with 18 sets of K^+p phase shifts. (L.B.S.)

41834 FINAL STATES $\eta\Lambda$ AND $\eta'\Lambda$ IN K^-p INTERACTIONS AT 3.95 GeV/c. Moscoso, L. (CEN, Saclay, France); Hubbard, J. R.; Rouge, A.; Videau, H. Phys. Lett.; 40B: No. 2, 285-8 (26 Jun 1972).

Final states $\eta\Lambda$ and $\eta'\Lambda$ were studied in K^-p interactions at 3.95 GeV/c. Cross sections, angular distributions and Λ polarizations are reported. The coupling ratio $R_T = (\eta_1\bar{K}K^{**}(1420)/(\eta_8\bar{K}K^{**}(1420))$ is found to be independent of the momentum transfer. Backward $\Lambda\eta$ is compared to $K^-p \rightarrow \Lambda\pi^0$, $\pi^\pm p \rightarrow p\pi^\pm$ and $\pi^-p \rightarrow n\pi^0$ at the same momentum. (auth)

41835 MEASUREMENTS OF SPIN ROTATION PARAMETERS IN PION–NUCLEON ELASTIC SCATTERING AT 6 GeV/c AND AT 16 GeV/c. de Lesquen, A.; Amblard, B.; Beurtey, R.; (and others) (CEN, Saclay, France). Phys. Lett.; 40B: No. 2, 277-80(26 Jun 1972).

The spin rotation parameter R was measured, at CERN, for

$\pi^{\pm}p$ at 6 GeV/c and for $\pi^{-}p$ at 16 GeV/c, with t ranging from −0.19 to −0.51 $(GeV/c)^2$. The parameter A was measured for $\pi^{-}p$ at 6 GeV/c in the interval between t = −0.19 and −0.14 $(GeV/c)^2$. The averaged values are the following: $R_{(+6)} = -0.08$ 0.04, $R_{(-6)} = -0.23 \pm 0.05$ and $R_{(-16)} = -0.23 \pm 0.05$. The values obtained for A are close to +1. (auth)

41836 EMISSION OF ^{8}Li BY HEAVY NUCLEI OF PHOTO-EMULSION EXPOSED TO 60 GeV PIONS. Weissenberg, A. O.; Kolganova, E. D.; Rabin, N. V. (Inst. of Theoretical and Experimental Physics, Moscow). Nuovo Cim.; 9A: No. 4, 534–46 (21 Jun 1972).

The yield, spectrum and angular distributions of ^{8}Li fragments emitted by heavy nuclei of emulsion exposed to 60 GeV pions are measured. It is shown that the velocity of the residual nucleus strongly depends on the number of cascade protons n_g. Taking account of this fact makes it possible to correlate the experimental data with the cascade evaporation model. (auth)

41837 DIFFERENTIAL CROSS SECTION FOR COHERENT PRODUCTION OF THREE-PION SYSTEMS ON NUCLEI AT 15.1 GeV/c. Bemporad, C. (CERN, Geneva); Beusch, W.; Milissinos, A. C.; (and others). Nucl. Phys.; B42: 627–43(1 Jun 1972).

The measured differential cross sections $d^2\sigma/dt'dm_{3\pi}$ of three-pion production on nine different nuclei (based on 40,000 events) are presented. The corrections due to the background of incoherent reactions and due to the limited angular resolution of the experiment are discussed. The comparison of the differential cross sections of coherent three-pion production with the optical model is satisfactory. (auth)

41838 DIFFERENTIAL CROSS SECTIONS FOR $K^{+}n$ CHARGE-EXCHANGE SCATTERING IN DEUTERIUM BETWEEN 0.64 AND 1.51 GeV/c. Giacomelli, G. (Univ., Bologna. INFN, Bologna); Lugaresi-Serra, P.; Minguzzi-Ranzi, A.; (and others). Nucl. Phys.; B42: 437–44(1 Jun 1972).

Results are presented on the differential cross sections for the process $K^{+}n \rightarrow K^{0}p$ extracted from the reaction $K^{+}d \rightarrow K^{0}pp$ measured at 13 momenta between 0.64 and 1.51 GeV/c. (auth)

41839 SEARCH FOR EXOTIC RESONANCES. Trilling, George H. (Univ. of California, Berkeley). pp 375–422 of Proceedings of the Fourth Hawaii Topical Conference in Particle Physics. /Yount, D. E. (ed.). Honolulu, Hawaii; Univ. of Hawaii Press (1972).

From fourth topical conference in particle physics; Honolulu, HI. (2 Aug 1971). See CONF-710819.

The status of the search for resonances in $K^{+} + p$ and $K^{+} + n$ systems is reviewed. Total and channel cross sections for the KN system, phase shift analysis for the I = 1 KN system and for the I = 0 system, and inelastic states produced in KN interactions are covered. (J.F.P.)

41840 SOME TOPICS IN BOSON SPECTROSCOPY. Trilling, George H. (Univ. of California, Berkeley). pp 494–534 of Proceedings of the Fourth Hawaii Topical Conference in Particle Physics. /Yount, D. E. (ed.). Honolulu, Hawaii; Univ. of Hawaii Press (1972).

From fourth topical conference in particle physics; Honolulu, HI. (2 Aug 1971). See CONF-710819.

Several systems in the natural spin and parity series are reviewed. The 2^{+} nonet, low-energy $K\pi$ and $\pi\pi$ spectroscopy, and higher-energy $\pi\pi$ and $K\pi$ scattering are covered. (J.F.P.)

Particle Interactions and Properties (Theoretical)

General

41841 (ITF–71-124-E) NEW PROOF OF ASYMPTOTIC EQUALITY OF DIFFERENTIAL CROSS SECTIONS. Medvedev, S. Yu.; Lomsadze, Yu. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 16p. Dep. NTIS (U. S. Sales Only).

A new proof of the asymptotical equality of differential cross sections of a direct and cross reactions for $s' \rightarrow \infty$ and fixed t′, and also for $s' \rightarrow \infty$ and $t' = t'(s')$ are given (the stroke above s and t indicates their belonging to the physical value region). This proof is based on the Meyman theorem 3, which makes it possible to demonstrate it under the weaker assumptions, than those in the equality proof, given by Meyman in 1964. (auth)

41842 (NP–19346) RESEARCHES IN THEORETICAL PHYSICS AND EXPERIMENTAL RESEARCHES IN ELEMENTARY PARTICLE PHYSICS. Annual Report, October 1970–September 1971. (Institutul de Fizica Atomica, Bucharest (Romania)). 35p. Dep. NTIS (U. S. Sales Only).

Abstracts of papers on physics research are presented covering nuclear, elementary particle, solid state, and reactor theory, and experimental work on elementary particles. (J.F.P.)

41843 (SLAC–144, pp 2.1-14) HIGH-ENERGY PHYSICS IN THE SEVENTIES. Sakurai, J. J. (California Univ., Los Angeles. Dept. of Physics). Mar 1972.

From Joint Japanese–U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

A review and possible future studies of high-energy physics is given and includes intermediate interactions, two-body reactions, multiparticle production, high-energy photoproduction, Bjorken scale invariance, diffraction, and weak interactions. (J.F.P.)

41844 INTRODUCTION TO PARTICLE PHYSICS. Omnes, Roland. New York; John Wiley and Sons, Inc. (1971). 426p.

Translated from the French by G. Barton.

An elementary introduction to particle physics and techniques in particle theory is presented. Topics discussed include a survey of particle properties, conservation laws, group theory, relativistic invariance, spin determination, CPT theory, nonrelativistic collision theory, bound states and resonances, Dirac equation, quantum electrodynamics, strong interactions, SU(3), Regge poles, and weak interactions. (C.E.S.)

41845 INCLUSIVE CROSS SECTION SUM RULES. Gupta, V. (Tata Inst. of Fundamental Research, Bombay). Lett. Nuovo Cim.; 4: No. 5, 161–4(3 Jun 1972).

For the derivation of sum rules involving moments of inclusive cross sections a method was previously given for obtaining all the moments from a master equation. These results are generalized to the case of various kinds of particles in the final state, which applies to the real world. (J.F.P.)

41846 POSSIBLE EXISTENCE OF A NEW PROCESS DURING INTERACTIONS AT ENERGIES ABOVE 10^{12} eV. Gavin, E.; Maz, R.; Vdovchik, E. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2138–43(Oct 1971). (In Russian).

It is suggested that three phenomena, the so-called X-process, horizontal showers, and muon-deficient showers, may be simultaneously explained by postulating the existence of a new process for interactions with energies in excess of 10^{12} eV. The chief feature of this process is the generation of a sufficiently weak interacting heavy particle with a relatively long lifetime. After discussing its relation to the three phenomena mentioned, predictions are offered based on the assumed model, and the probable properties of the intermediate particle are suggested, with reference to possible future investigations. (K.S.W.)

41847 POLARISATION EFFECTS IN INCLUSIVE REACTIONS. Phillips, R. J. N.; Ringland, G. A.; Worden, R. P. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Lett.; 40B: No. 2, 239–44(26 Jun 1972).

Various possible polarization measurements are distinguished, and their theoretical significance is discussed. (i) It has previously been noticed that simple Regge pole models forbid polarization effects for the non-fragmenting particle. An absorptive mechanism is proposed which can give rise to polarization asymmetry in this limit and detail the distinctive predictions of this model. Comments are made on the implications of duality in the missing mass for these polarization effects. (ii) There are no dynamical reasons for polarization effects to be forbidden for the fragmenting particle or its fragment. The use of polarization effects in this kinematic region is proposed as a sensitive test of factorization. (iii) A number of experiments, with and without polarized targets is suggested. (auth)

41848 GENERALIZED SUM RULES FROM NULL-PLANE COMMUTATORS. Furlan, G. (Univ., Trieste, Italy. International Centre for Theoretical Physics, Trieste, Italy); Jengo, R.; Rebbi, C. Nuovo Cim.; 9A: No. 4, 487–503(21 Jun 1972).

A general method to derive sum rules from null-plane commutators is discussed. The main point is the definition of the null-plane commutators through a procedure of analytic continuation, that naturally leads to the Khuri representation in momentum space. The result is a general expression for the asymptotic expansion of the Fourier transform of the null-plane commutator: the constant part reproduces the fixed-mass relations, while the role of the additional contributions depends on the dynamics. A simple derivation of the Bloom–Gilman sum rule is also presented. (auth)

41849 APPROXIMATE RELATIVISTIC COULOMB HAMILTONIAN. Sheth, C. V.; Swamy, N. V. V. J. (Oklahoma State Univ., Stillwater). Phys. Rev., D; 5: No. 10, 2659-62(15 May 1972).

It is shown that an approximate Dirac–Coulomb Hamiltonian can be defined which possesses exact solutions. These solutions are as simple as those of the symmetric Hamiltonian given by Biedenharn and Swamy. The degeneracy of the energy levels is seen to be the same as that of the Dirac–Coulomb Hamiltonian. The Green's function of this new Hamiltonian is also given. This Hamiltonian adequately supplements the use of the symmetric Hamiltonian. (auth)

41850 MULTIPLICITY DISTRIBUTION AND INTEGRATED MOMENTUM DISTRIBUTION FUNCTIONS IN HIGH ENERGY HADRON PRODUCTION PROCESSES. Koba, Z.; Nielsen, H. B.; Olesen, P. (Niels Bohr Institutet, Copenhagen). Phys. Norv.; 5: No. 3-4, 301-10(1971).

The generating function formalism is applied to an empirical formula of Czyzewski and Rybicki on the multiplicity distribution in hadronic production processes below 30 GeV. Integrals of a few particle momentum distribution and correlation functions are evaluated, and the importance of testing the validity of empirical regularity $\langle n\rangle/D \approx$ const. and/or the behavior of correlation integrals at higher energies is emphasized. (auth)

41851 DYNAMICAL SOLUTION TO THE SUGAWARA MODEL. Joseph, A. (Tel-Aviv Univ., Israel). Nucl. Phys.; B42: 418-36 (1 Jun 1972).

Starting from the equal-time commutator and equation of motion for the currents in the Sugawara current algebra model, the commutator at all space-time separations is obtained in closed form. It is verified that this expression obeys Lorentz covariance and has vanishing divergence with respect to both sets of variables. The antisymmetry and Jacobi identity properties of the commutator are examined and its singularity structure discussed. (auth)

41852 PROCEEDINGS OF THE FOURTH HAWAII TOPICAL CONFERENCE IN PARTICLE PHYSICS, HONOLULU, HAWAII, AUGUST 2-13, 1971. Yount, D. E.; Dobson, P. N. (eds.). Honolulu, Hawaii; University of Hawaii Press (1972). 639p. $12.00. (CONF-710819).

The conference included 16 papers. Separate abstracts were prepared for all papers. (J.F.P.)

For abstracts of individual papers see: 41774–41776, 41802, 41803, 41839, 41840, 41853, 41854, 41908, 41923–41925, 42012, 42020, and 42032.

41853 INCLUSIVE PROCESSES AT VERY HIGH TRANSVERSE MOMENTUM. Bjorken, James D. (Stanford Linear Accelerator Center, Calif.). pp 261-324 of Proceedings of the Fourth Hawaii Topical Conference in Particle Physics. /Yount, D. E. (ed.). Honolulu, Hawaii; Univ. of Hawaii Press (1972).

From fourth topical conference in particle physics; Honolulu, HI. (2 Aug 1971). See CONF-710819.

Deep inelastic inclusive processes at very high transverse momentum are treated using a generalization of the parton model. About twenty such processes are listed and briefly described. (J.F.P.)

41854 MULTI-HADRONIC REACTIONS AT HIGH ENERGIES. Frazer, William R. (Univ. of California, San Diego, La Jolla). pp 535-631 of Proceedings of the Fourth Hawaii Topical Conference in Particle Physics. /Yount, D. E. (ed.). Honolulu, Hawaii; Univ. of Hawaii Press (1972).

From fourth topical conference in particle physics; Honolulu, HI. (2 Aug 1971). See CONF-710819.

Lectures are given on the general features of multiparticle reactions including some very general observations, longitudinal kinematics, inclusive spectra, scaling, the Mueller analysis of inclusive reactions, the short-range correlation hypothesis, and partial cross sections and multiplicity distributions. Also some models of multiparticle reactions are covered including the Chew–Pignotti multiperipheral model, the diffractive fragmentation picture for Hwa's model, and the statistical thermodynamical model. (J.F.P.)

Electromagnetic

Refer also to abstracts 41754, 42047, and 42049.

41855 (CONF-710816-7) PHOTOPRODUCTION OF ETA MESONS IN A WEAK REGGE CUT MODEL. Goldstein, Gary R.; Owens III, Joseph F. (Tufts Univ., Medford, Mass. Dept. of Physics). Jul 1971. 16p. Dep. NTIS.

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

Recent data on η photoproduction is interpreted in the framework of a weak Regge cut model in which the ρ, ω, and B' trajectories contribute. The energy dependence suggested by the Gornell data is accounted for by such a model. Further, it is shown that the older SLAC and DESY experiments are consistent with such an energy dependence. (auth)

41856 (JINR–E2-6473) SCATTERING OF LIGHT BY LIGHT THROUGH TWO-PION STATE. Isaev, P. S.; Khleskov, V. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 8p. Dep. NTIS (U. S. Sales Only).

Cross sections of s and d waves for the light–light scattering due to two-pion intermediate state are calculated from the $\gamma\gamma \to \pi\pi$ partial amplitudes. (auth)

41857 (JINR–E2-6490) AUTOMODEL ASYMPTOTIC IN QUANTUM FIELD THEORY. II. Bogolyubov, N. N.; Tavkhelidze, A. N.; Vladimirov, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 50p. Dep. NTIS (U. S. Sales Only).

The process of deeply inelastic scattering of electrons by protons is considered the probability of which is expressed in terms of the imaginary part of the amplitude of the virtual Compton effect. It is proved that the form factors W_1 and W_2 are causal and the Jost–Lehmann–Dyson representation can be used for them. Some restrictions on the weight functions of this representation leading to the automodel asymptotic of the deeply inelastic amplitude are found. With these restrictions the current commutator behavior near the light cone is derived and a connection between the singularities on the light cone and the asymptotic behavior of the form factors is established. (auth)

41858 (SLAC–144, pp 11.1-21) WHAT IS VECTOR-MESON DOMINANCE? COMPARISONS OF SINGLE-PION PHOTOPRODUCTION AND ρ PRODUCTION IN PION–NUCLEON COLLISIONS. Sakurai, J. J. (California Univ., Los Angeles. Dept. of Physics). Mar 1972.

From Joint Japanese–U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

The vector dominance model for invariant amplitudes is discussed. Comparisons are made between the reaction $\pi^- + p \to \rho^0 + n$ and the $\gamma + p \to \pi^+ + n$ and $\gamma + n \to \pi^- + p$. (J.F.P.)

41859 FACTORISATION AND INCLUSIVE PHOTOPRODUCTION. Chang, Hong-mo (Rutherford High Energy Lab., Chilton, Eng.); Miettinen, H. I.; Lam, W. S. Phys. Lett.; 40B: No. 1, 112-16(12 Jun 1972).

Inclusive photoproduction cross sections for $\pi^\pm$ and Λ in the fragmentation region of the proton are predicted via factorization from hadron initiated reactions. Comparison with existing data is favorable. (auth)

41860 DETERMINATION OF THE SCALE DIMENSION OF CHIRAL SYMMETRY BREAKING HAMILTONIAN FROM THE PS. MESON PHOTOPRODUCTION. Chikashige, Y.; Inagaki, H. (Tokyo Metropolian Univ.). Phys. Lett.; 40B: No. 1, 117-20(12 Jun 1972).

The scale dimension of the chiral symmetry breaking Hamiltonian was determined to be $d_u = 2$ by using the experimental information on the forward differential cross section for high energy ps. meson photoproduction under the assumption of the P. C. A. C. and the conservation of the scale dimension on the light cone. (auth)

41861 GENERALIZED VECTOR DOMINANCE AND INELASTIC ELECTRON–PROTON SCATTERING. Sakurai, J. J.; Schildknecht, D. (Univ. of California, Los Angeles). Phys. Lett.; 40B: No. 1, 121-6(12 Jun 1972).

A model of inelastic electron-proton scattering is proposed, which takes into account the coupling of the photon to higher-mass vector states. Both the virtual photon-proton cross section σ_T (predicted with essentially no adjustable parameters) and the q^2 dependence of R are in exceedingly good agreement with the SLAC-MIT data in the diffraction region. (auth)

41862 MEASUREMENT ON HYDROMAGNETIC WAVES AS A METHOD FOR EVALUATING THE REST MASS OF A PHOTON. Gintsburg, M. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Dokl. Akad. Nauk SSSR; 201: No. 4, 817-19(1 Dec 1971). (In Russian).

The tensor of electric permeability of a plasma in electrodynamics with a nonzero rest mass of the photon is treated. The dispersion of hydromagnetic waves is proposed for evaluating the latter. The solution to the problem is extended to Alfvén and magnetoacoustic waves in the interplanetary plasma. (K.S.W.)

41863 POLARIZATION EFFECTS DURING PHOTOPRODUCTION OF PAIRS IN A MAGNETIC FIELD. Lysov, B. A.; Pavlova, O. S.; Zhuravlev, A. F. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 5, 557-62(Sep-Oct 1971). (In Russian).

The influence of a magnetic field on the process of generating electron-positron pairs from two photons was investigated. The cases of both weak and strong fields were examined. In weak fields the "field" contribution to the cross section of the process possesses resonance character and is proportional to $\sqrt{H}$. The cross sections of production of longitudinally and transversely polarized particles were obtained. (tr-auth)

41864 MULTIPHOTON PRODUCTION OF LEPTON PAIRS IN THE FIELD OF A NUCLEUS. Loskutov, Yu. M.; Zakhartsov, V. M. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 5, 553-6(Sep-Oct 1971). (In Russian).

The formation of lepton pairs e^+e^-, $\mu^+\mu^-$ by a monoenergetic beam of circularly polarized γ quanta in a nuclear field was investigated. In the event the density of the photon flux is not too high a cross section of the process is obtained, taking account of the polarized states of the leptons. (tr-auth)

41865 ELECTROMAGNETIC AND WEAK INTERACTIONS IN NONLINEAR QUARK THEORY. Kurdgelaidze, D. F. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 5, 601-3(Sep-Oct 1971). (In Russian).

All kinds of macroscopic forces (e.g., molecular, surface, etc.) are manifest as phenomena of Coulombic interaction in dependence on different conditions. Also, in the theory of elementary particles strong, electromagnetic, and weak interactions become phenomena of one, nonlinear interaction of some "pro-matter" in dependence on various conditions. "Pro-matter" is here identified with a quark field. In agreement with this, all possible decays in the region of elementary particles should find a solution within the framework of "pro-matter"—in this particular case—quarks. (K.S.W.)

41866 QUANTUM PROCESSES IN A FIELD OF ELECTROMAGNETIC WAVES AND A CONSTANT MAGNETIC FIELD. Zhukovskii, V. Ch.; Kherrmann, I. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 5, 617-20(Sep-Oct 1971). (In Russian).

The Compton effect, the induced Compton effect, and pair production by two photons in a constant magnetic field were examined. The spectral distributions of intensity for the Compton effect in the presence and in the absence of a magnetic field were calculated. (K.S.W.)

41867 COMPARISON BETWEEN THE BILOCAL ALGEBRA ON THE LIGHT CONE AND THE PARTON MODEL. Chaichian, M. (Univ., Hamburg). Nucl. Phys.; B42: 333-9(1 Jun 1972).

The bilocal algebra on the light cone is used to obtain the structure functions for the reaction "γ" + nucleon → "γ" + anything, where one or both of the photons are highly virtual and in a special kinematical region of large momentum transfer between the two photons. It predicts a scaling behavior for the structure functions and connects them to the structure functions of the deep inelastic lepton scattering. The impulse approximation of Bjorken and Paschos to the quark parton model gives exactly the same result even when both photons are real. This shows the identity of bilocal algebra and the quark parton model with general distribution functions in the domain where both models are applicable and further either puts some doubt on the validity of parton model when only one or none of the photons is highly virtual or justifies the dominance of the leading light cone singularity for these cases if one assumes the complementarity of the two pictures. (auth)

41868 COUPLING OF THREE OR MORE POSITRONIUMS: A RELATIVISTIC MODEL OF COUPLING OF COMPOSITE PARTICLES. Aydin, Z. Z.; Barut, A. O. (Univ. of Colorado, Boulder). Nucl. Phys.; B42: 291-300(1 Jun 1972).

Because the eikonal approximation has the nontrivial features of providing falling form factors and correct relativistic mass formula for the bound-states, it can be taken as a theoretical laboratory to derive S-matrix elements of n composite particles (or reggeons) from an underlying S-matrix element of 2n elementary particles. For definiteness the coupling of positroniums is considered. In this approximation a formula is derived for the coupling of three or more positroniums as a function of their principal quantum numbers. The amplitude vanishes as the mass of each composite particle vanishes. A number of applications and the extension of the amplitude to those having "duality" properties are pointed out. (auth)

41869 ELECTROMAGNETIC COUPLINGS FROM THE COMBINED USE OF FORWARD AND BACKWARD DISPERSION RELATIONS. Baacke, J.; Kleinert, H. (Freie Univ., Berlin). Nucl. Phys.; B42: 301-24(1 Jun 1972).

Sum rules are derived for the isovector electromagnetic transition moments $N^{**} \rightarrow N^{*}\gamma$ where N^{*}, N^{**} are arbitrary resonances. The derivation is based on the following assumptions: the isospin odd amplitudes of the scattering process $N^{**}\pi \leftarrow N^{*}\pi$ obey unsubstracted dispersion relations in forward as well as in backward direction; the coupling constants of the s channel resonances are given, to a good approximation, by existing solutions of the algebra of axial charges; the t-channel contribution of these amplitudes is dominated by a single ρ meson; and the $N^{**}N^{*}\rho$ coupling constant can be related to the electromagnetic couplings $N^{**}N^{*}\gamma$ via vector meson dominance. The equations are tested by a calculation of the known couplings of the nucleon and the $\Delta N\gamma$ transition. The results agree well with experiment. Then the isovector couplings $R(1470)N\gamma(K^V_{RN} \approx 1.2)$, $R(1470)R\gamma(K^V_{RR} \approx 1.3)$, where R (1470) is the $\frac{1}{2}^+$ Roper resonance are predicted. It is concluded that R(1470) should be seen in photoproduction on the deuteron. (auth)

41870 INFRARED DIVERGENCE AND INCIDENT PHOTONS. de Calan, C.; Valent, G. (Ecole Polytechnique, Paris). Nucl. Phys.; B42: 268-80(1 Jun 1972).

Similar to the usual infrared divergence corresponding to the emission of soft photons, there is an increasing behavior of the probability amplitudes for processes including incident photons with lower and lower energies. It is shown that such a behavior is only apparent: it vanishes already in a first-order perturbation theory. This cancellation occurs when all the experimentally indistinguishable processes are taken into account, in a way quite different however from the well known infrared compensation between radiated and virtual soft photons. (auth)

41871 PHOTOPRODUCTION OF CHARGED PIONS ON DEUTERON. Leroy, J. P.; Micheli, J.; Pignon, D. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B42: 173-93(1 Jun 1972).

The study of charged pions photoproduction on deuterium is made. Special attention is paid to the $\pi^-\pi^+$ ratio. Using the multipole set of Berends, Donnachie and Weaver, the agreement with experiment is satisfactory up to 250 MeV, although the value obtained for the $\pi^-\pi^+$ ratio is a little small at very low energy. For higher energy, one cannot reproduce the recent data of Bonn and Lodi Rizzini et al. In view of the large uncertainties on the multipoles, it does not seem to be possible to extract the $g\rho\pi\gamma$ coupling constant from experiments. (auth)

41872 CURRENT DENSITIES AND OPERATOR PHENOMENOLOGY ON THE LIGHT CONE. Kummer, W. (Univ. of Pennsylvania, Philadelphia). Nucl. Phys.; B42: 141-52(1 Jun 1972).

For any inclusive or exclusive process, which is determined by a matrix element of two current densities, in general a large number of different limits of the Bjorken type for the invariant variables can be found leading to light cone dominance. The same is true for certain semi-hadronic processes at low external momenta, but with the emphasis on the ultra-violet region for the internal integration. It is proposed to include in the general light cone expansion of two current densities—to be used in conjunction with the limits mentioned above—besides the vector and axial-vector current densities, also the other Dirac densities (scalar, pseudoscalar, tensor). The formalism describes then half integer powers in corrections to scaling laws as well. (auth)

41873 TESTS OF COMPLEX SCALING AND REGGE BEHAVIOR OF COMPTON AMPLITUDES. Healy, J. B.; Khuri, N. N. (Rockefeller Univ., New York). Phys. Rev., D; 5: No. 11, 2763-8 (1 Jun 1972).

A numerical evaluation of the complex-scaling sum rules is given. The results indicate that the concept of precocious complex scaling is in agreement with the present data on $W_2(\nu,q^2)$. It is shown that these sum rules can discriminate between different Regge fits to the electroproduction data and place restrictions that go beyond those imposed by the finite-energy sum rules. (auth)

41874 RADIATIVE CORRECTIONS TO THE INVARIANT-MASS SPECTRUM OF A DALITZ PAIR. Mikaelian, K. O.; Smith, J. (State Univ. of New York, Stony Brook). Phys. Rev., D; 5: No. 11, 2890-5(1 Jun 1972).

An analytic formula is derived from the radiative corrections to the invariant-mass spectrum of a Dalitz pair. The result is applied to the decay $\eta \rightarrow \gamma e^+e^-$. (auth)

41875 UNITARIZATION OF THE PION ELECTROMAGNETIC FORM FACTOR IN THE SMOOTHED VENEZIANO MODEL. Chia,

T. C.; Hama, M.; Kiang, D. (Dalhousie Univ., Halifax, N. S.). Phys. Rev., D; 5: No. 11, 2814-18(1 Jun 1972).

A simple method is presented to unitarize the pion electromagnetic form factor by smoothing the Veneziano-type model. The weight function is chosen so as to satisfy the unitarity in the elastic region. Two typical types of the Veneziano form factors are unitarized and compared with the experimental data. (auth)

41876 FINITE CONTRIBUTION IN THE PROTON - NEUTRON MASS DIFFERENCE. Brandt, R. (New York Univ., N. Y.); Ng, Wing-chiu; Vinciarelli, P. Lett. Nuovo Cim.; 4: No. 6, 210-12 (10 Jun 1972).

It is found that the sum of the finite Born term and the fixed-pole contributions to the proton–neutron mass difference has no definite magnitude or sign. (J.F.P.)

41877 ELECTROMAGNETIC INTERACTIONS BETWEEN PARTICLES WITH ARBITRARY SPIN BASED UPON WEINBERG'S EQUATION. Eeg, J. O. (Univ. of Oslo). Lett. Nuovo Cim.; 4: No. 6, 223-7 (10 Jun 1972).

Calculations of cross sections for particles with arbitrary spin based on the Joos–Weinberg equation, which is a generalization of the Dirac equation, are presented. (J.F.P.)

41878 EXACT ENERGY EIGENVALUES FOR AN ATTRACTIVE COULOMB POTENTIAL WITH ZERO-RADIUS HARD CORE. Kumar, N. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett.; 39A: No. 5, 389-90(5 Jun 1972).

Following a peratization procedure, the exact energy eigenvalues for an attractive Coulomb potential, with a zero-radius hard core, are obtained as roots of a certain combination of digamma functions. The physical significance of this entirely new energy spectrum is discussed. (auth)

41879 SEMICLASSICAL MODEL OF THE ELECTRON CONTAINING TACHYONIC MATTER. Ramachandran, G. N.; Ramachandran, G.; Tagare, S. G. (Indian Inst. of Science, Bangalore). Phys. Lett.; 39A: No. 5, 383-4(5 Jun 1972).

It is shown that the mass of the electron could be conceived as the energy associated with its spinning motion and the angular velocity is such that the linear velocities at the surface exceed the velocity of light; this in fact accounts for its stability against the centrifugal forces in the core region. (auth)

41880 TRANSITION EFFECT IN ELECTRON–PHOTON SHOWERS. Kol'chuzhkin, A. M.; Ryzhov, V. V.; Uchaikin, V. V. (Tomsk Polytechnic Inst., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2171-5(Oct 1971). (In Russian).

The development of an electron-photon cascade was studied in a homogeneous medium A, in which there is located a plane layer of another substance B, giving rise to a "transition effect". Formulas are developed which are applicable to either an ionization chamber or a scintillation counter. (K.S.W.)

41881 SOME REMARKS ON FERMION PAIR CREATION IN AN ALTERNATING EXTERNAL FIELD. Perelomov, A. M. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett.; 39A: No. 5, 353-4(5 Jun 1972).

The group-theoretical aspects of the problem of fermion pair creation in an alternating external field are discussed. It is shown that the dynamical symmetry group of the problem is the SU(2N) group where $N = 2S + 1$, S being the spin of the particle. (auth)

41882 EFFECTIVE FIELD EQUATIONS FOR ONE-ELECTRON MULTI-PHOTON STATIONARY STATES. Brett, A. M. (Drexel Univ., Philadelphia). Nuovo Cim.; 9B: No. 2, 377-98 (11 Jun 1972).

The nonperturbative Rayleigh-Ritz procedure for functionalities is applied to the quantum theory of the interaction of an electron with the electromagnetic field in certain approximations. The procedure yields effective field equations, the solutions to which enable one to evaluate quantities of physical significance. Application to Compton scattering is considered. (auth)

41883 ATTENUATION LENGTH FOR HIGH-ENERGY γ-RAYS IN THE RELICT RADIATION. Allcock, M. C. (Univ. of Durham, Eng.); Wdowczyk, J. Nuovo Cim.; 9B: No. 2, 315-20 (11 Jun 1972).

Detailed calculations of the interaction of electrons and photons with the relict radiation (inverse Compton effect and pair production process, respectively) were made. The attenuation length for energy and intensity of the photons and electrons was thereby established. (auth)

41884 PHOTON IN CONTEMPORARY PHYSICS. Kresin, V. Z.; Tavger, B. A. Priroda; No. 11, 64-7(Nov 1971). (In Russian).

This brief review discusses the concept of the photon from the time of Tamm's corpuscular theory (1929). The properties of an oscillator and its energy levels, the comparison of a phonon and a photon, and the concepts of quasiparticles and a Fermi surface are introduced. (K.S.W.)

41885 ASYMMETRY OF THE ANGULAR DISTRIBUTIONS OF SECONDARY PARTICLES IN A SPECIAL-PURPOSE DIGITAL COMPUTER AND OF THE AZIMUTHAL PLANE AT ENERGIES OF SEVERAL HUNDREDS OF GeV. Babaev, M. K.; Eremenko, Yu. A.; Lukin, Yu. T.; Takibaev, Zh. S. (Inst. of High Energy Physics, Alma-Ata, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2036-9(Oct 1971). (In Russian).

The number of asymmetric showers was calculated on the basis of a fireball model. For a sufficient statistical assurance, the asymmetry parameters are sensitive to collective movement of secondary particles for energies of the order of several hundreds of GeV. Existing experimental data are not at variance with the generation of one fireball in 25 to 50% of the cases. (tr-auth)

41886 ARE THERE FIXED SINGULARITIES IN T_1? Zee, A. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., D; 5: No. 11, 2829-32(1 Jun 1972).

Nonforward scaling and the light-cone commutator are shown to require the existence of a Kronecker δ term in T_1. The present data may be consistent with the possibility that this Kronecker δ term vanishes at $t = 0$ and $q^2 = -\infty$. Analyticity implies a connection between scaling behavior and Regge behavior. (auth)

41887 THEORY OF DYNAMICAL TRANSITION RADIATION PRODUCTION. Bakhshyan, G. G.; Garibyan, G. M. (Inst. of Physics, Erevan. Inst. of Radio Physics and Electronics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 6: No. 3, 174-85 (1971). (In Russian).

When considering the production of transition radiation with wave lengths less than the distance between the atoms of the substance, it is necessary to have such a theory which deals with nonsolid structure of the substance. In a work proposed, the dynamical theory of the transition radiation is developed, the radiation being due to the scattering of the charge-in-flight field on separate atoms forming the substance considered. (auth)

41888 X^0 PHOTOPRODUCTION IN A PERIPHERAL MODEL. Matinyan, S. G.; Shakhnazaryan, Yu. G. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 6: No. 3, 151-5 (1971). (In Russian).

On the basis of Dar, Watts and Weisskopf's "new peripheral model" the photoproduction of X^0 from nucleons is considered. The dependences of the cross section $[d\sigma/dt(\gamma p \rightarrow pX^0)]$, of the ratio $[d\sigma/dt(\gamma n \rightarrow nX^01)]/[d\sigma/dt(\gamma p \rightarrow pX^0)]$ and of the asymmetry ratio $\Sigma = (\sigma_\perp - \sigma_{||}/\sigma_\perp + \sigma_{||})$ connected with the linear polarization of the photons on the square of momentum transfer t at various energies are obtained. (auth)

41889 NATURE OF THE SCALE-INVARIANCE BREAKING TERM IN INELASTIC e–p SCATTERING FROM DGS REPRESENTATION. Majumdar, D. P. (Univ. of Michigan, Ann Arbor). Phys. Lett.; 40B: No. 2, 272-6(26 Jun 1972).

Using the DGS representation and the scaling phenomena it is suggested that the nature of the scale breaking term of νW_2 in inelastic e-p scattering, should be of the form $G_2(\omega)M^2/Q^2$. Using Regge theory it is then predicted that $G_2(\omega)$ would be a constant for large ω, and is estimated to be approximately -0.06. These predictions, in particular the constancy of the slopes for νW_2 versus $1/Q^2$ plots for large ω ($\omega > 8$), compare very well with the recent experimental data. Similar results for $W_1(\nu,Q^2)$ are also discussed. (auth)

41890 PARTON–ANTIPARTON CONTRIBUTIONS TO PHOTON–PHOTON SCATTERING. Kunszt, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 40B: No. 2, 220-4 (26 Jun 1972).

The contributions of spin 0 and spin ½ bare particles to the process $\gamma^* + \gamma^* \rightarrow$ hadrons are calculated. Various asymptotic regions are discussed with the help of the light cone singularities and the algebra of bilocal operators to see under which conditions the parton-antiparton contributions may be regarded as a good approximation. Prospects of future experimental tests are investigated. (auth)

41891 PROTON–NEUTRON MASS DIFFERENCE IN CONFIGURATION SPACE. Ng, Wing-chiu (New York Univ., N. Y.);

Vinciarelli, Patrizio. Phys. Rev., D; 5: No. 10, 2566-75(15 May 1972).

It is argued that the canonical structure of light-cone singularities should break down at distances of the order of 10^{-16} cm. It is proposed that this be the separation from the light cone of the boundary of a region where configuration-space structure functions effectively lose their x^2 dependence. A new formula for the proton-neutron mass difference is derived as a limit of configuration-space invariant amplitudes. The above conjecture is then used for a numerical estimate which happens to be in excellent agreement with the experimental value. Finally bilocal operators are exhibited in the quark-gluon model responsible for divergences in $\Delta I = 1$ electromagnetic mass shifts. (auth)

41892 MODEL-INDEPENDENT DEEP-INELASTIC ELECTROPRODUCTION SUM RULES. Palmer, David R. (Univ. of Rochester, N. Y.). Phys. Rev., D; 5: No. 10, 2575-81(15 May 1972).

Using the most general form for the null-plane commutator of the electromagnetic current, sum rules are derived for electroproduction in the deep-inelastic region. The structure of these sum rules is discussed and a free, massless, fermion model is considered as an illustration. (auth)

41893 PARTONS, ELECTROMAGNETIC MASS SHIFTS, AND THE APPROACH TO SCALING. Weisberger, William I. (State Univ. of New York, Stony Brook). Phys. Rev., D; 5: No. 10, 2600-9(15 May 1972).

In parton models the most singular part of the electromagnetic level shift of a physical state is predicted to be a weighted sum of the level shifts of the partons. This leads to a tadpole model for masses squared. Requiring consistency of this result with Cottingham's formula leads to a prediction of the cross section for absorption of virtual scalar as well as transverse photons in the Bjorken scaling limit. If these cross sections are in a particular ratio to each other, mass shifts or differences will be finite in conventional electrodynamics. (auth)

41894 LIGHT-CONE ANALYSIS OF SPIN-DEPENDENT DEEP-INELASTIC ELECTRON SCATTERING. Hey, A. J. G.; Mandula, J. E. (California Inst. of Tech., Pasadena). Phys. Rev., D; 5: No. 10, 2610-14(15 May 1972).

The light-cone analysis of deep-inelastic electron-proton scattering is extended to non-spin-averaged scattering. Scaling is deduced for the spin-dependent structure functions $M^2\nu G_1$ and $M\nu^2 G_2$. The connection between moments of the scaling functions and matrix elements of operators in the operator-product expansion is described in detail and leads to two sum rules for the scaling functions when the quark light-cone algebra of Fritzsch and Gell–Mann is assumed. Predictions of other models of scaling are briefly compared. (auth)

41895 SCALING AND THE NUCLEON FORM FACTORS: INFORMATION ON Z_2 AND THE DRELL–YAN–WEST RELATION. Broadhurst, D. J. (Stanford Univ., Calif.). Phys. Rev., D; 5: No. 10, 2615-22(15 May 1972).

New rigorous bounds on the discontinuities of off-shell nucleon form factors are systematically derived and used in two applications. First, upper limits of between 0 and 0.3 are set on Z_2, the proton's wave-function renormalization constant, under different assumptions about R, the ratio of longitudinal to transverse virtual photoabsorption cross sections, in the Bjorken limit, and about possible subtraction constants in the sideways dispersion relations for nucleon form factors. The bounds on $Z_2^{-1} - 1$ represent an improvement by factors of 8 and 32 over previous results and permit a conclusion without neglect of a subtraction constant. If the $J^\pi = 1/2^+$ contributions to deep-inelastic scattering do not scale, $Z_2 = 0$ in any case. Second, it is suggested that the Drell–Yan–West relation is the extremum of an inequality imposed by unitarity and analyticity. This is the case if the off-shell Dirac form factor $F(s,Q^2)$, near $s = m^2$, is a smooth but nontrivial function of s, as $Q^2 \rightarrow \infty$, whether or not the $J^\pi = 1/2^+$ contributions scale. (auth)

41896 POSSIBLE EXCHANGE DEGENERACY ON THE LIGHT CONE. Fishbane, Paul M. (Univ. of Illinois, Urbana. Univ. of Virginia, Charlottesville); Freedman, Daniel Z. Phys. Rev., D; 5: No. 10, 2582-92(15 May 1972).

The sum rule $\int d\xi\,\xi^{-1}(F_2^{ep} - F_2^{en}) = 1/3$ and the stronger exchange-degeneracy relation $F_2^{ep} - F_2^{en} = 1/6\,(F_2^{\bar{\nu}p} - F_2^{\nu p})$ between electron- and neutrino-scattering ($\Delta S = 0$ transitions) structure functions are obtained in some versions of the quark-parton model. The most general conditions are identified under which the relations above are obtained both in parton models and in the formal light-cone algebra of quark-gluon field theories. In the light-cone approach the necessary condition is a support property for Fourier transforms of bilocal-operator matrix elements. The exchange-degeneracy relation is checked in perturbation theory for γ_5 and γ_μ gluon models. A class of graphs which violates exchange degeneracy is identified, whose members all have exotic intermediate $q\bar{q}$ states. These graphs are, in every order of perturbation theory, suppressed in the Bjorken limit by powers of $\log q^2$ compared to the leading graphs. Therefore in such renormalizable theories exchange degeneracy is correct to leading $\log q^2$ order. (auth)

41897 COMPARISON OF THE PARTON AND LIGHT-CONE ANALYSES OF HIGHLY INELASTIC LEPTONIC PROCESSES. Jaffe, Robert L. (Stanford Univ., Calif.). Phys. Rev., D; 5: No. 10, 2622-40(15 May 1972).

The relationship between the parton model and the analysis of light-cone singularities for highly inelastic leptonic processes is studied. For deep-inelastic lepton scattering the parton model is found to be a momentum-space representation of any model in which free-field singularities on the light cone are dominant. Scaling laws and sum rules derived in one approach are shown to obtain in the other with equivalent assumptions. For massive-muon-pair production the two approaches are found to differ fundamentally. In the parton model the leading singularity is dominated in the high-mass limit by the nonsingular annihilation diagram. The scaling law which is obtained in the parton model is not obtained from a light-cone analysis without additional, seemingly arbitrary assumptions. Massive-muon-pair production therefore tests the parton model in a region where it is not equivalent to the light-cone approach. Several other processes are studied including one-particle inclusive e^+e^- annihilation and photoproduction of muon pairs. (auth)

41898 HIGH-INTENSITY COMPTON SCATTERING AND THE ORIGIN OF THE WAVELENGTH SHIFT WITHIN THE FRAMEWORK OF A SEMICLASSICAL TREATMENT. Richard, J. L. (Univ. of Texas, Austin). Phys. Rev., D; 5: No. 10, 2650-4 (15 May 1972).

Using group-theoretical arguments, it is shown that the nonlinear wavelength shift predicted by Goldman and by Brown and Kibble in high-intensity Compton scattering comes about from the particular symmetry properties of the circularly polarized plane wave used to describe the laser beam. (auth)

41899 ANALYTIC EQUIVALENCE OF THE GUPTA-BLEULER FORMALISM AND OF AN S-MATRIX FORMALISM FOR PROCESSES INVOLVING PHOTONS. Stern, H. (CEN de Saclay, Gif-sur-Yvette, France). Nuovo Cim.; 9A: No. 4, 515-33(21 Jun 1972).

The equivalence of the analyticity properties whether formulated in an S-matrix formalism introduced by Zwanziger or in the usual quantum electrodynamical formalism is studied. Although the description of the photon appears completely different in these two formalisms, the mentioned equivalence is established for interactions of a single photon with hadrons, with exception of the case where the hadrons interact with magnetic monopoles. (auth)

41900 POLARIZATION IN DEEP INELASTIC SCATTERING FROM THE LIGHT-CONE QUARK ALGEBRA. Wray, D. (Weizmann Inst. of Science, Rehovoth, Israel). Nuovo Cim.; 9A: No. 4, 463-78(21 Jun 1972).

Deep inelastic electron and neutrino scattering for polarized targets are considered. Making the analysis from the light-cone quark algebra of Fritzsch and Gell–Mann, sum rules are obtained for the structure functions which contribute to polarization. It is also found that parton model results are contained in the light-cone results. Experimental implications are considered. (auth)

41901 ELECTROPRODUCTION OF π-MESONS ON NEUTRON IN THE THRESHOLD REGION. Omelaenko, A. S. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 11, 1817-21(Nov 1971). (In Russian).

In the framework of Salin's isobaric model specified for the threshold region the reaction $en \rightarrow e'p\pi^-$ is considered at low energies. Contributions to a differential cross section due to transverse state of the virtual photon are in a considerable dependence on charge neutron form factor G_{E_n} and those due to the scalar part of the amplitude are sensitive to the pion form factor F_π. Both types of contributions change with a variation in these form factors in the same way as in case of the reaction $ep \rightarrow e'n\pi^+$. (auth)

41902 CONNECTION OF NEUTRAL VECTOR MESON PHOTOPRODUCTION PROCESSES ON NUCLEI WITH THE PROCESSES OF π- AND K-MESON INTERACTION WITH NUCLEI. Rekalo, M. P. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh.

(Russ. Ed.); 16: No. 11, 1843-9(Nov 1971). (In Russian).

The quark model, in which meson quarks interact with nuclei as a whole, is suggested for the neutral vector meson photoproduction processes on the nuclei. Differential cross-sections of the processes $\gamma + A \rightarrow A + V^0$ at $t = 0$ may be connected with the total cross-sections of π- and K-meson interaction with the nuclei. The predicted A-dependence of the vector meson photoproduction cross section is in good agreement with the experimental data for the reaction $\gamma + A \rightarrow A + \rho^0$. The vector-dominance hypothesis allows one to calculate in this model the absolute values of $d\sigma/dt$ ($\gamma d \rightarrow d\rho$) which do not contradict existing experimental data. (auth)

41903 EFFECTIVE POTENTIAL METHOD FOR COMPUTATION OF QUANTUM SYSTEMS. III. RELATIVISTIC WAVE FUNCTIONS AND EIGENVALUES. Zapol, B. P.; Kunin, P. E.; Taksar, I. M.; Fabrikant, I. I. (Latvian State Univ., Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 1, 3-12(1972). (In Russian).

A relativistic electron in an effective potential is considered. Wave functions are expressed with Whittaker's functions and with a new solution of Whittaker's equation proposed earlier. The calculation of energy eigenvalues is described. The oscillation theorem for the radial part of the great component of the electron wave function in the central field is proved. The domain of the radial function's zeroes is determined and the mode of the domain division in the segments of nonoscillation is shown. An algorithm is constructed which allows one to determine the principal quantum number of a state with given energy, angular momentum, and parity. (auth)

41904 ANNIHILATION AND SCATTERING OF POLARIZED PARTICLES WITH A ½ SPIN. **Shakhnazaryan, Yu. G. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 6: No. 4, 235-54(1971). (In Russian).**

On the basis of a common form for the tensor of electromagnetic interaction of the particles with a ½ spin taking into account their form factors and polarizations, the expressions for the differential cross section of the annihilation of the polarized nonpoint leptonic pairs into an arbitrary two-particle state are obtained. Some questions of a possible violation of quantum electrodynamics at small distances are investigated. The expressions for the differential cross section of the polarized nonpoint leptons scattering on a target with an arbitrary spin and for the polarization vector of the scattered lepton are presented. Some concrete processes are considered as the examples. (auth)

41905 ELECTROMAGNETIC INTERACTIONS OF PARTICLES WITH SPIN. II. ELECTRON BREMSSTRAHLUNG AND PAIR PRODUCTION. Waldenstroem, S.; Olsen, H. Ark. Fys. Seminar Trondheim; No. 3, 1-30(1972).

Bethe–Heitler cross sections for electron bremsstrahlung and pair production in the field of a target particle of arbitrary spin are obtained including recoil effects. Formulas for extreme relativistic energies are obtained as special cases. A formula for symmetric pair production, valid for all energies and emission angles, is given. Inelastic target processes are included in a straight forward manner. (auth)

41906 HIGH VIRTUAL MASS CURRENTS AND OPERATOR PRODUCTS AT NEARLY LIGHT-LIKE DISTANCES. Frishman, Y. (Weizmann Inst. of Science, Rehovot, Israel). Acta Phys. Austr.; 34: No. 4, 351-86(1971).

Lectures are given on the properties and predictions of the proposed light cone expansions of products of local operators. The motivation is a connection between the results on deep inelastic e + p scattering which exhibited a scaling property and the structure of the matrix element between proton states of a commutator of two currents at nearly light like distances. Short distance expansions and anomalous dimensions, short distance behavior and e + p scattering, light cone expansions of operator products, deep inelastic e + p scattering, exclusive reactions in which the nonforward matrix elements of $\gamma + p \rightarrow p + \pi$ interactions are considered, and the nonforward matrix elements for Compton scattering of a virtual photon off a nucleon are discussed. (J.F.P.)

41907 FORM-FACTOR EFFECTS OF HADRONS IN HADRONIC ATOMS. Schroeder, U. E. (Univ., Frankfurt am Main). Acta Phys. Austr.; 34: No. 3, 235-41(1971).

In hadronic atoms the energy levels are shifted by the form factors of the hadrons involved. For K^-, $\bar{p}$ and Σ^- atoms the estimate of this effect leads to energy shifts $\Delta E \lesssim 10^{-2}$ eV. In the case of pionic atoms it is found that for 1s levels the energy shift may amount to 327 eV. (auth)

41908 HADRON FINAL STATES IN DEEP-INELASTIC PROCESSES: GENERAL CONSIDERATIONS. Bjorken, James D. (Stanford Linear Accelerator Center, Calif.). pp 242-60 of Proceedings of the Fourth Hawaii Topical Conference in Particle Physics. /Yount, D. E. (ed.). Honolulu, Hawaii; Univ. of Hawaii Press (1972).

From fourth topical conference in particle physics; Honolulu, HI. (2 Aug 1971). See CONF-710819.

Inclusive deep inelastic processes are considered in general terms. The colliding beam process $e^+ + e^-$ (via single γ) $\rightarrow$ hadrons is discussed; this includes W^+ and W^- decay into hadrons. Both the transverse and longitudinal momentum distributions of the secondary hadrons are treated. Also the inclusive hadron spectrum in electroproduction on nucleons and nuclei is studied. The nature of the distribution as a function of Q^2 and s, the squared mass of the produced hadron system, is examined. (J.F.P.)

Weak

Refer also to abstracts 41774, 41775, 42015, and 42032.

41909 (JINR–E2-6412) THEORY OF UNIVERSAL WEAK INTERACTION OF LEPTONS. Filippov, A. T. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 10p. Dep. NTIS (U. S. Sales Only).

A theory of weak leptonic interactions based on invariance with respect to rotations and reflections of the 4-dimensional leptonic isospace (R_4-symmetry) is suggested. The Lagrangian of leptonic interactions has the form $L_L = \frac{1}{8} G(\bar{\psi}\alpha_{ij}\psi)(\bar{\psi}\alpha^{ij}\psi)$, where $\alpha_{ij} = (2i)^{-1}[\alpha_i, \alpha_j]$, $\{\alpha_i \alpha_j\} = 2\delta_{ij}$, $\psi = (\nu_e, e^-, \nu_\mu \mu^-)$. The muonic charge conserves multiplicatively. The highest divergences may be eliminated by using R_4-symmetry and by renormalizing the coupling constant G. The relations among different processes ($\mu^- \rightarrow e^-\bar{\nu}_e\nu_\mu$, $\mu^- \rightarrow e^-\nu_e\bar{\nu}_\mu$, $\nu_e e^- \rightarrow \nu_e e^-$, $\nu_\mu e^- \rightarrow \nu_\mu e^-$, $e^-e^- \rightarrow \mu^-\mu^-$, etc.) predicted by the theory are valid in all orders of perturbation theory with the unitary cut-off $L \approx G^{-\frac{1}{2}}$. (auth)

41910 (JINR–P2-6329) RADIATIVE DECAYS $\pi(K) \rightarrow l\nu_l\gamma$. Bardin, D. Yu.; Bilen'kii, S. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). Apr 1972. 28p. (In Russian). Dep. NTIS (U.S. Sales Only).

Decays $\pi(K) \rightarrow l\nu_l\gamma$ are considered. The dependence of the form factors on the squared momentum of the lepton pair Q^2 is taken into account. It is shown that measurement of the positron and photon spectra under the condition that the angles between their momenta are greater than some value would allow one to unambiguously determine the γ parameter (for the case of $\pi \rightarrow e\nu_e\gamma$-decay) as well as to test the CVC hypothesis. The measurement of spectra in $K \rightarrow l\nu_l\gamma$-decays gives the possibility of getting information about all the parameters of the amplitude. The lepton longitudinal polarization is calculated. (auth)

41911 BINDING ENERGY OF HYPERNUCLEI FROM K^- CAPTURE. Roy, T.; Daftri, I. K. (Jadavpur Univ., Calcutta). Indian J. Phys.; 44: No. 11, 610-12(Nov 1970).

The mesic decays $\Lambda\text{-}^7Li \rightarrow {}^7Be + \pi^-$ and $\Lambda\text{-}^{10}Be \rightarrow \pi^- + {}^{10}B$ yield a binding energy of 5.92 and 8.90 MeV respectively for the decaying hypernuclei. These hypernuclei are produced in K^- reactions at rest in emulsions. (J.F.P.)

41912 LOW-ENERGY NEUTRINO MUONS AT GREAT DEPTHS. Bergamasco, Laura; Piazzoli, Benedetto D'Ettorre; Piano, Angelo. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 50: No. 6, 735-43(Jun 1971).

The muon neutrino energy spectrum at sea level and the ratio R_ν of muon production with muon energy above 160 MeV to the total flux ($R_\nu = 4.6(10)^{-2}$) and the differential and total cross sections for muon production from neutrino interactions with nucleons in rock are calculated. (J.F.P.)

41913 STRUCTURE OF LEPTONS. Kitazoe, T. (Kobe Univ., Japan). Lett. Nuovo Cim.; 4: No. 5, 196-8(3 Jun 1972).

It is found that composite systems of the fundamental entities ν and W composing an electron and a muon, to account for their different masses, can give a natural explanation of the weak interaction composed of the charged currents only and of the neutrino-flip experiments. The model also gives a new interpretation of the ordinary weak bosons. (J.F.P.)

41914 MULTIPERIPHERAL THEORY OF DEEP-INELASTIC NEUTRINO–NUCLEON SCATTERING. Tow, Don M. (Inst. for Advance Study, Princeton, N. J.). Phys. Rev., D; 5: No. 11, 2795-2803(1 Jun 1972).

The recently proposed multiperipheral theory of deep-inelastic electron-nucleon scattering is applied to deep-inelastic neutrino-nucleon scattering. The behavior of the structure functions is derived in the limit of large energy ν ($\nu \equiv p \cdot q/m$), and large momentum transfer squared q^2, with $\omega \equiv 2m\nu/(-q^2)$ fixed but large. In particular, scaling is derived. The model predicts that an energetic nucleon-antinucleon pair should be produced in this limit. The model also predicts that $[d\sigma^{\nu p}]/[d(1/\omega)] + [d\sigma^{\nu n}]/[d(1/\omega)] > [d\sigma^{\bar{\nu}p}]/[d(1/\omega)] + [d\sigma^{\bar{\nu}n}]/[d(1/\omega)]$, and the inequality approaches at a known rate an equality as $\omega \to \infty$. The natural scaling variable that arises in the model is $\omega \equiv (p + q)^2/(-q^2)$. The generality of the derivation, in the sense of requiring only Regge behavior and a particular asymptotic off-shell dependence, is discussed. The multiperipheral theory is compared with theories based on other models. (auth)

41915 NUCLEAR INTERACTIONS OF COSMIC-RAY MUONS WITH MATTER. Bezrukov, L. B.; Beresnev, V. I.; Zatsepin, G. T.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2155-9(Oct 1971). (In Russian).

The data of a number of workers on nuclear showers, nuclear interactions of muons with lead nuclei and NaCl nuclei, and inelastic scattering of muons are discussed in the framework of models of Heitler, Hand, and others. (K.S.W.)

41916 UPPER LIMIT FOR THE CONSTANT OF $\nu_\mu - \mu$ INTERACTION FROM THE CERN NEUTRINO EXPERIMENT. Kaftanov, V. S.; Khovanskii, V. D.; Kubantsev, M. A. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett.; 40B: No. 2, 215-16(26 Jun 1972).

From the CERN neutrino spark chamber experiment on W-boson search an upper limit for a constant G_D of $\nu_\mu - \mu$ interaction is calculated. $G_D < 20\ G_F$ on a 90% confidence level, where G_F is the Fermi constant. (auth)

41917 BPH APPROACH TO WEAK INTERACTIONS. Preparata, G. (Univ., Rome). Phys. Lett.; 40B: No. 2, 253-6(26 Jun 1972).

A Bogoliubov–Parasiuk–Hepp renormalization program for the usual Fermi Lagrangian is proposed. All second order processes are given in terms of only two subtraction constants associated with "counter terms" exhibiting a high degree of lepton–hadron universality. (auth)

41918 OPERATOR-PRODUCT EXPANSIONS, NEUTRINO SCATTERING, AND THE DIMENSION OF THE SYMMETRY-BREAKING HAMILTONIAN. Brown, Stanley G. (Univ. of California, Los Angeles). Phys. Rev., D; 5: No. 10, 2593-2600 (15 May 1972).

The structure functions W_4 and W_5 in inelastic neutrino-nucleon scattering are analyzed, using Wilson operator-product expansions. The ν dependence of the structure functions in the Bjorken scaling limit is related to the dimensions (Δ_i) of the terms in the SU(3) ⊗ SU(3)-breaking Hamiltonian. Restrictions due to positive definiteness are used. Several applications of the analysis are made: (1) If the axial-vector current behaves as a canonical pion field, then there must exist a field of dimension ≤ 0. (2) A "maximal-contribution assumption" implies that Δ_1, the largest of the Δ_i, is ≥ 2. (3) A proposed experimental determination of Δ_1 is analyzed. (4) Implications for internal-symmetry structure of the vanishing of W_L are discussed. (auth)

41919 CURRENT-ALGEBRA SUM RULES IN NEUTRINO SCATTERING AND SCALE DIMENSION OF THE CHIRAL-SYMMETRY-BREAKING HAMILTONIAN. Fayyazuddin (Univ. of Islamabad, Pakistan); Riazuddin. Phys. Rev., D; 5: No. 10, 2641-9 (15 May 1972).

Current-algebra sum rules for the structure functions W_4 and W_5 which occur in neutrino scattering because of the nonconservation of the axial-vector current are derived and used to get information about the scaling behavior of W_4 and W_5. This information together with the light-cone analysis is used to determine the scale dimension of the chiral-symmetry-breaking Hamiltonian. (auth)

41920 EXPLICIT SOLUTION OF LEE'S MODEL WITH FERMI COUPLING. Exposito, F. (CNR, Naples); Monroy, G.; Esposito, U. Nuovo Cim.; 9A: No. 4, 479-86(21 Jun 1972).

Lee's model with Fermi coupling in the lower sectors is studied. The equations for Green's functions in the sectors $N + \Theta$ and $N + 2\Theta$ are given. The equation in the sector $N + \Theta$ is solved and the results briefly discussed. (auth)

41921 ANTINEUTRINO SCATTERING BY POLARIZED ELECTRON. Akulov, V. P. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 11, 1855-8(Nov 1971). (In Russian).

The differential cross sections of the antineutrino elastic scattering by a polarized electron are calculated in the model of neutrino with a magnetic moment. The cross sections are shown to be strongly dependent on the initial electron polarization. The upper limit of the neutrino mass with a magnetic moment is obtained. (auth)

41922 LOCAL AND UNITARY TWO PARTICLE SATURATION APPLIED TO K_{l3} DECAY. Gromes, D. (Univ., Heidelberg). Nucl. Phys.; B42: 480-92(1 Jun 1972).

A saturation of the commutator matrix element $\langle 0|[A_\mu^3, V_\nu^{4-i5}]|K^+\rangle$ which includes $K\pi$ scattering states is performed, yielding a local approximation. The application of the current algebra relation leads to two equations of the Callan–Treiman type which hold for physical arguments of the form factors. One of them gives an interesting connection between the parameters of K_{l3} decay. (auth)

41923 FUNDAMENTAL PROPERTIES OF WEAK INTERACTIONS: SOME INVESTIGATIONS BY DIVERSE TECHNIQUES. Cronin, James W. (Univ. of Chicago). pp 33-61 of Proceedings of the Fourth Hawaii Topical Conference in Particle Physics. /Yount, D. E. (ed.). Honolulu, Hawaii; Univ. of Hawaii Press (1972).

From fourth topical conference in particle physics; Honolulu, HI. (2 Aug 1971). See CONF-710819.

The lecture on the fundamental properties of weak interactions by diverse techniques includes purely leptonic processes, nuclear double beta decay, weak interactions involving hadrons, recent experiments on nuclear decay, two-nucleon interactions, and nuclear beta decay. (J.F.P.)

41924 PHENOMENOLOGY OF DEEP-INELASTIC PROCESSES: NO FINAL-STATE HADRONS OBSERVED. Bjorken, James D. (Stanford Linear Accelerator Center, Calif.). pp 211-30 of Proceedings of the Fourth Hawaii Topical Conference in Particle Physics. /Yount, D. E. (ed.). Honolulu, Hawaii; Univ. of Hawaii Press (1972).

From fourth topical conference in particle physics; Honolulu, HI. (2 Aug 1971). See CONF-710819.

Theory and experimental data are reviewed for deep inelastic scattering with no hadrons observed in the final state. The reactions $e^- + N \to e^- +$ hadrons, $\mu^- + N \to \mu^- +$ hadrons, $\nu + N \to \mu^- +$ hadrons, and $\bar{\nu} + N \to \mu^+ +$ hadrons are considered. (J.F.P.)

41925 LIGHT-CONE COMMUTATORS: MODELS OF THE STRUCTURE FUNCTIONS. Bjorken, James D. (Stanford Linear Accelerator Center, Calif.). pp 231-41 of Proceedings of the Fourth Hawaii Topical Conference in Particle Physics. /Yount, D. E. (ed.). Honolulu, Hawaii; Univ. of Hawaii Press (1972).

From fourth topical conference in particle physics; Honolulu, HI. (2 Aug 1971). See CONF-710819.

As an illustration that the deep inelastic structure functions are directly related to commutators of currents at light-like separation the structure function W_1 is considered. The light-cone approach and parton models are discussed. (J.F.P.)

Strong (General)

Refer also to abstracts 41777 and 41781.

41926 CHARGE INDEPENDENCE RESTRICTIONS ON SOME HIGH ENERGY TWO-BODY PROCESSES. Dass, G. V.; Froyland, J. (CERN, Geneva). Nucl. Phys.; B42: 153-72(1 Jun 1972).

Bounds due to isospin invariance were considered for spin effects and for the unpolarized cross sections in some situations of experimental interest. Dynamical consequences like possible structure in the near-forward direction and some knowledge of the strength of the real part of the forward scattering amplitude follow in a model-independent way from these isospin bounds for the unpolarized differential cross sections for $np \to np$ scattering and $K^\pm n \to K^\pm n$ scattering at high energies. Useful bounds for the differential cross sections for high energy $\bar{p}n \to \bar{p}n$ scattering and for the high-energy reactions $\pi N \to \rho N$ and $KN \to K^*(890)N$ (and also bounds for the full observed density matrix of the vector meson) were illustrated. Some simple implications of the rotation of the reference axes (about the normal to the production plane) for the resonance density matrix bounds are pointed out. Some other applications are discussed. (auth)

41927 PROPERTIES OF HADRONIC AMPLITUDES IN AN ABSORPTIVE MODEL. Harari, Haim; Schwimmer, Adam (Stanford Univ., Calif.). Phys. Rev., D; 5: No. 11, 2780-94 (1 Jun 1972).

Hadronic two-body amplitudes involve two components. The imaginary part of the nondiffractive component R is dominated by the most peripheral impact parameters ($b \sim r$). The imaginary part of the diffractive component P has substantial contributions from all impact parameters $b \lesssim r$. The energy dependence of the b representations of both components as well as various possible forms for the corresponding real parts are studied. It is shown that the following three assumptions are mutually inconsistent: (i) ImR(s,t) is always dominated by b ~ r terms; (ii) ImR(s,t) shrinks indefinitely as $s \to \infty$; (iii) r approaches a constant as $s \to \infty$. Three classes of models obtained by abandoning, one at a time, these three assumptions, are defined. The complex-J-plane structure as well as the asymptotic phase of the R amplitude for each of these classes are studied and various experimental ways of distinguishing between the models are proposed. A detailed analysis of ReR indicates that, while in certain cases it reaches its asymptotic phase at relatively low energies, in other cases the asymptotic phase is approached very slowly and it has no resemblance to the observed phase at present energies. (auth)

41928 MULTIPLE PROCESSES. Daibog, E. I.; Rozental, I. L. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2044-8(Oct 1971). (In Russian).

Possible collective interactions during particle collisions at very high energy are examined. Experiment indicates in favor of a hydrodynamic type of model as compared to a peripheral-statistical model. (tr-auth)

41929 REGGE BEHAVIOR FOR INCLUSIVE ANNIHILATION AND DECAY PROCESSES. Rittenberg, V.; Rubinstein, H. R. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Lett.; 40B: No. 2, 257-9(26 Jun 1972).

By exploiting annihilation processes it is shown that inclusive experiments are also relevant at low energies, if duality holds. Questions concerning the Pomeron background relationship in this energy regime, can be studied by simple, feasible experiments, proposed in this note. (auth)

41930 COMPATIBILITY OF THE DUAL POMERON WITH UNITARITY AND THE ABSENCE OF GHOSTS IN THE DUAL RESONANCE MODEL. Goddard, P.; Thorn, C. B. (CERN, Geneva). Phys. Lett.; 40B: No. 2, 235-8(26 Jun 1972).

It is shown that the number of states coupling in the Veneziano model when the space time dimension, d, is 26 ($d = 10$ for the Neveu-Schwarz model) is reduced in such a way that the Pomeron is probably a pole. A simple consequence of this counting is the absence of ghosts for $d \leq 26$ ($d \leq 10$ for Neveu-Schwartz). (auth)

41931 INCLUSIVE BOOTSTRAP CONSTRAINTS ON DIFFRACTION DISSOCIATION. Yesian, H. J. (Univ. of California, Berkeley). Phys. Lett.; 40B: No. 2, 211-14(26 Jun 1972).

Combining Mueller analysis with the momentum conservation sum rule for inclusive reactions, it is found that certain sums of diffractive cross sections should factorize in a simple manner. Application of two-component duality for Pomeron-particle amplitudes then leads to Pomeron-f proportional couplings at $t = 0$ and a universal probability for total diffraction dissociation. (auth)

41932 DYNAMICS UNDERLYING DUALITY AND GAUGE INVARIANCE IN THE DUAL-RESONANCE MODELS. Chang, Lay Nam (Univ. of Pennsylvania, Philadelphia); Mansouri, Freydoon. Phys. Rev., D; 5; No. 10, 2535-42(15 May 1972).

Making use of the similarity between the factorized spectrum of the generalized beta function and the spectrum of a vibrating string in Minkowski space, a formalism is constructed within which a geometrical interpretation to the gauge symmetries inherent in the theory is given. The key point in the construction is the identification of the harmonic-oscillator amplitude with the components of actual coordinates in space-time. It turns out that these coordinates must satisfy certain constraints arising from purely geometrical considerations, and these constraint equations are then shown to be the familiar gauge conditions on the underlying states. Analogies with more familiar gauge theories are pointed out. (auth)

41933 REGGE POLES AND ELEMENTARY PARTICLES. Eden, R. J. (Cambridge Univ., Eng.). Rep. Progr. Phys.; 34: No. 11, 995-1053(1971).

This review of Regge theory is intended both as an introduction to its main features and as a survey of its relation to experimental results on the strong interactions of elementary particles. It includes a survey of the experimental and theoretical background that is required from an understanding of Regge theory. The central part of the review describes the basic ideas of Regge theory and the application of Regge pole models to high-energy collisions of elementary particles. The review concludes with a brief account of extensions of Regge theory that give the Veneziano representation and that give some features of many-particle production in high-energy collisions. (auth)

41934 MULTI-REGGEON EFFECTS FOR INCLUSIVE REACTIONS IN THE PIONIZATION REGION. Botke, J. C. (Cambridge Univ., Eng.). Nucl. Phys.; B42: 589-606(1 Jun 1972).

The non-leading behavior of the inclusive differential cross section (IDCS) in the pionization region by considering a number of Gribov-Feynman graphs which are related to the IDCS through Mueller's generalized optical theorem. In addition to "normal" regge cut dependence, $(\ln s)^{-1}$, a dependence of the form $S^{(\mathrm{const})p_\perp^2}$ $(\ln s)^{-1}$ is found, which has no analogy in two-body scattering. (auth)

41935 UNITARIZATION OF DUAL MODELS AND BOOTSTRAP. Panchapakesan, N.; Ramachandran, R. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 5: No. 10, 2656-8(15 May 1972).

Using the statistical approach, a sum rule for the coupling parameter is obtained. It indicates the necessity for a nonperturbative approach to unitarization in dual models. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 41840 and 42018.

41936 (IS-T-519) PHENOMENOLOGY BASED UPON THE GENERALIZED VENEZIANO MODEL. Johnson, David Edwin (Ames Lab., Iowa). May 1972. Contract W-7405-eng-82. 56p. Dep. NTIS.

Thesis.

This study is made of the reactions $\bar{p}p \to \bar{p}p\pi^0$, $\bar{p}n\pi^+$, and $p\bar{n}\pi^-$ at 2.9 GeV/c using a model which combines Pomeron diffraction-dissociation diagrams with the generalized Veneziano model diagrams. Three model parameterizations, which differ in their relative amounts of Pomeron and dual amplitudes allowed, are examined for the $\bar{p}p\pi^0$ final state, and all are found to be in good agreement with the data. It is impossible to obtain a reasonable fit for the $\bar{p}n\pi^+$ and $p\bar{n}\pi^-$ final states with this model. (auth)

41937 (NP-19355) HIGH-ENERGY SCATTERING OF CHARGED VECTOR MESON IN STATIC FIELD: SIMPLE EXPONENTIATION AND S-CHANNEL HELICITY CONSERVATION. Meng, Ta-chung (Freie Universitaet, Berlin (West Germany). Institut fuer Theoretische Physik). Mar 1972. 26p. Dep. NTIS (U. S. Sales Only).

It is shown that (a) validity of s-channel helicity conservation and (b) occurrence of simple exponentiation depend on the coupling between the vector-meson and the external field. Both (a) and (b) can be realized in a theory where the charged vector-meson has an anomalous magnetic moment ($\mathcal{K} = 1$) and where the external charge distribution is not too singular. (auth)

41938 (SLAC-144, pp 1.1-14) QUARKS, DUALITY, AND STRUCTURE OF HADRONS. Hara, Yasuo (Tokyo Univ. of Education (Japan). Dept. of Physics). Mar 1972.

From Joint Japanese-U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

The hadron is suggested to be composed of qqq or $q\bar{q}$, and a core consisting of an infinite number of $q\bar{q}$ pairs. The hadronic levels in the model are discussed. The s-channel helicity conservation is also discussed. (auth)

41939 (SLAC-144, pp 9.1-3) DOES THE f-MESON BEHAVE LIKE A MASSIVE GRAVITON? Takeda, Gyo (Tohoku Univ., Sendai (Japan)). Mar 1972.

From Joint Japanese-U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

The differential cross sections of the reaction $\pi + N \to f + N$ are calculated in the Born approximation in order to study whether the f meson behaves like a massive graviton and couples to the conserved energy and momentum tensor. It is found that further studies are necessary in order to test this hypothesis. (J.F.P.)

41940 (SLAC-144, pp 10.1-8) PION-PION SCATTERING: APPLICATION OF THE THEORY OF INTERMEDIATE NUCLEAR STRUCTURE. Takeda, Gyo (Tohoku Univ., Sendai (Japan)). Mar 1972.

From Joint Japanese-U. S. seminar on elementary-particle physics with bubble chamber detectors; Stanford, CA. (24 Feb 1971).

The Veneziano model of pion-pion scattering is used to treat the occurrence of intermediate structure such as that found in nuclear reactions in the intermediate energy regions. The escape width and compound width of the doorway states are discussed. (J.F.P.)

41941 ODORICO ZEROS AND LOW ENERGY $\pi\pi$ SCATTERING DATA. Pennington, M. R.; Protopopescu, S. D. (Univ. of California, Berkeley). Phys. Lett.; 40B: No. 1, 105-8(12 Jun 1972).

Recent $\pi^+\pi^-$ scattering results show an anomalous behavior in the $\langle Y_1^0 \rangle$ moment of the angular distribution at 980 MeV. Odorico has suggested that this effect is unrelated to the opening of $K\overline{K}$ threshold but is explained by the straight line propagation of zeros which enter the physical region near 980 MeV. A similar explanation was also given for an "anomaly" in $\pi^-\pi^0$ scattering at roughly the same energy. It is shown that the zeros of both the $\pi^+\pi^-$ and $\pi^-\pi^0$ elastic scattering amplitudes, as determined from the data, contradict these suggestions of Odorico and, in fact, illustrate the effect of K^+K^- threshold in $\pi^+\pi^-$ scattering. (auth)

41942 HIGH ENERGY DIFFRACTION SLOPES AND THE CHOU-YANG MODEL. Carreras, B. (Junta de Energia Nuclear, Madrid); White, J. N. J. Nucl. Phys.; B42: 95-101(1 Jun 1972).

The ISR and Serpukhov measurements of the pp diffraction slope are successfully accounted for by the Chou–Yang model, with dipole form factor and $\mu^2 = 0.71$, generalized to include an energy dependent interaction term. The diffraction slope for Kp scattering is also considered. The apparent constancy of Kp and $\bar{p}p$ slopes is compatible with the model if a surface interaction of radius ≃1 fm is introduced. (auth)

41943 EMPIRICAL EXTENSION OF THE NEVEU-SCHWARZ MODEL. Fairlie, D. B. (Univ. of Durham, Eng.). Nucl. Phys.; B42: 253-67(1 Jun 1972).

It is shown that the Neveu–Schwarz model takes a simple form in the Koba–Nielsen formulation, the integrand taking the form of a Pfaffian. It is found empirically that it is possible to improve the spectrum while retaining the Pfaffian formulation. Though the form obtained for the amplitude is suggestive of an underlying operatorial construction there was no success in finding such a formulation. The Adler condition is implemented in this model in a nontrivial manner. (auth)

41944 ENERGY-MOMENTUM TENSORS AND Z-DIAGRAMS. Genz, H. (Univ., Karlsruhe, Ger.); Katz, J.; Kuehnelt, H. Nucl. Phys.; B42: 102-8(1 Jun 1972).

The discussion of Z–diagrams is extended to equal-time commutators of the charges $Q_D^\alpha(0) = \int d^3x x^m T_{0m}^\alpha(x)$ with space and time components of currents J_μ and their divergences. (Any symmetric energy-momentum tensor within the Callan–Coleman–Jackiw class parametrized by α is denoted by $T_{\mu\nu}^\alpha$.) The requirement of absence of Z-diagrams in the infinite momentum limit for boson matrix elements of either of the equal time commutators $[Q_D^\alpha(0), \partial^\mu J_\mu(0)]$, $[T_\mu^{\alpha\mu}(0)]$ or $[Q_D^\alpha(0), J_k(0)$ restricts the energy-momentum tensor to the new and improved one. This tensor $T_{\mu\nu}$ satisfies the preceding requirement and, as a consequence, Z-diagrams do not contribute in the infinite momentum limit to boson matrix elements of the commutators $[Q_D(0), \partial^\mu J_\mu(0)]$, $[T_\mu^\mu(0), Q(0)]$ and $[Q_D(0), J_k(0)]$ (with Q_D the dilatation charge). For fermion matrix elements of $[Q_D(0), \partial^\mu J_\mu(0)]$ Z-diagrams do give a contribution in the infinite momentum limit. Furthermore, in this limit no Z-diagrams contribute to fermion matrix elements of $[Q_D(0), J_\mu(0)]$ and to boson matrix elements of $[Q_D^\alpha(0), J_o(0)]$ (for any α). Moreover, assuming one particle saturation in the infinite momentum limit of both meson and fermion matrix elements of $[Q_D(0), \partial^\mu J_\mu(0)]$ and $[T_\mu^\mu(0), Q(0)]$ one consistently derives that $\partial^\mu J_\mu$ has dimension two if it has a dimension at all. (auth)

41945 CONSTRAINTS ON THE D-WAVE FOR $\pi^0\pi^0 \to \pi^0\pi^0$ SCATTERING. Common, A. K.; Pidcock, M. K. (Univ. of Kent, Canterbury, Eng.). Nucl. Phys.; B42: 194-204(1 Jun 1972).

Crossing and positivity of the scattering amplitude are used to improve the constraints on the derivative of the d-wave previously obtained by one of the authors and to derive an infinite set of inequalities between the values of the d-wave at three points in the unphysical region. These inequalities are checked against a number of models and some qualitative conclusions drawn. (auth)

41946 HIGH-ENERGY BOUNDS FROM LOW-ENERGY DATA. Blankenbecler, Richard; Savit, Robert (Stanford Univ., Calif.). Phys. Rev., D; 5: No. 11, 2757-9(1 Jun 1972).

A method for deriving rigorous upper bounds on asymptotic values of total cross sections is discussed. The size of the bound is determined by low-energy data. A functional form for the total cross section at high energies is assumed and bounds on the parameters introduced are obtained. The method is applied to $\pi-\pi$ scattering, and numerical estimates, using experimental data, are given for different parametrizations. For an asymptotically constant $\sigma_T(s)$, we find $\sigma_T(\infty) \lesssim 40$ mb. Better data would improve the accuracy of this bound and could lower it significantly. (auth)

41947 σ-COMMUTATOR TERM AND PION–PION SCATTERING. Chan, Francis C. P. (Saginaw Valley Coll., Mich.). Phys. Rev., D; 5: No. 11, 2818-21(1 Jun 1972).

The pion–pion scattering amplitude on the mass shell is constructed for low energy in terms of the σ term. A couple of models are discussed in connection with this approach and the pion–pion S-wave scattering lengths are estimated to be compared with Weinberg's prediction in the σ model. it is found that the ratio of the scattering lengths generally depends only on the ratio of the isospin components in the σ commutator. (auth)

41948 X^0 (960)-MESON SPIN-PARITY DETERMINATION BY $X^0 \to \rho^0\gamma$ DECAY. Zaslavskii, A. N.; Solakhyan, V. P. Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 6: No. 3, 156-60(1971). (In Russian).

It is shown that the measurement of the polarization of γ-quantum in $X^0 \to \underset{\lfloor\!\to \pi^+\pi^-}{\rho_0\gamma}$ decay allows one, in principle, to make a choice between the two now existing hypotheses on the spin-parity of the X^0 (960)-meson: J^P $(X^0) = 0^-$ and J^P $(X^0) = 2^-$. (auth)

41949 CROSSING SYMMETRIC, DUAL AMPLITUDE WITH GEOMETRICAL STRUCTURE. Hosoya, A.; Tokuda, N. (Tokyo Univ.). Phys. Lett.; 40B: No. 2, 208-10(26 Jun 1972).

A model of crossing symmetric, dual geometrical amplitude is constructed, which has poles corresponding to resonances and shows the geometrical structure as well as the Regge behavior at high energy. It is applied to the process $A_1\pi \to \pi\pi$. (auth)

41950 DUALITY STRUCTURE OF $\pi\pi$, $K\pi$ PHASE SHIFTS. Eguchi, T.; Igi, K. (Tokyo Univ.). Phys. Lett.; 40B: No. 2, 245-9(26 Jun 1972).

Marked regularities of $\pi\pi$, $K\pi$ phase shifts recently observed by several experimental groups are shown to be understood from the viewpoint of a new bootstrap scheme of duality. A speculation is also made about how the dips in $\pi\pi$, $K\pi$ S-wave phase shifts could be realized in the above scheme. (auth)

41951 UNITARY AND CROSSING SYMMETRIC S- AND P-WAVE PION–PION SCATTERING AMPLITUDES. Widder, F. (Univ., Graz). Acta Phys. Austr.; 34: No. 3, 264-78(1971).

A unitarization procedure for the inverse amplitude is applied to simple linear models in order to generate (elastic) unitary and crossing symmetric partial wave amplitudes. Postulating the ρ resonance, one is left with five free parameters which are determined by the requirement that the five crossing sum rules be fulfilled as well as possible. In this way one arrives at a unique solution which furthermore satisfies all the other rigorous constraints. This solution predicts large values for the I = 0 S-wave phase shift, corresponding to a very broad σ resonance. The scattering lengths are $a_0^0 = 0.15\ m_\pi^{-1}$, $a_0^2 = -0.064\ m_\pi^{-1}$ and $a_1^1 = 0.037\ m_\pi^{-3}$, in agreement with various experimental and theoretical estimates. (auth)

41952 PHYSICAL REGION CROSSING RELATIONS AND CONSTRAINTS ON $\pi^0\pi^0$ PARTIAL WAVES IN THE UNPHYSICAL REGION. Grassberger, P. (Univ., Bonn). Nucl. Phys.; B42: 461-79(1 Jun 1972).
Domains in the Mandelstam triangle $0 < s_1, s_2, s_1 + s_2 < 4$, for which inequalities of the type $f_0(s_1) < f_0(s_2)$ can be proven rigorously, are enlarged. In particular, $f_0'(s) < 0$ for $0 \leq s < 1.219$ is obtained. The main technical tools are the physical region crossing conditions derived recently by Roy and others. It is shown that these domains nearly are the largest ones obtainable from crossing, analyticity and positivity. With essentially the same method, it is also proved that the slope of the D-wave is negative for $1.435 < s < 4$. These inequalities are then further strengthened by including information on the S-wave in the physical region. Finally, two recent models are tested and found to violate some of the inequalities. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 41802, 41839, and 42026.

41953 (LYCEN–7203) NEW METHOD FOR DETERMINATION OF $\pi-N$ SCATTERING AMPLITUDES. Giffon, M.; Laverriere, R. (Lyon Univ. (France). Institut de Physique Nucleaire). Jan 1972. 18p. Dep. NTIS (U.S. Sales Only).

Using recent measurements of the R^{+-} rotation parameters, a simple method for determining the various $\pi-N$ scattering amplitudes is proposed. The results are compared with those obtained previously and also with those of the Regge model and finite energy sum rule (F.E.S.R.). (France)

41954 (RLO–2141-61) CORRELATION BETWEEN THE LEADING-PARTICLE DISTRIBUTIONS IN πp AND pp COLLISIONS. Hwa, Rudolph C. (Oregon Univ., Eugene). Oct 1971. Contract AT(45-1)-2230. 9p. Dep. NTIS.

The flatness of the leading-particle distributions in πp and pp collisions at large c.m. longitudinal momenta is explained in terms of single-excitation processes. Their heights are related to their total cross sections and a certain universality relation is shown to exist between the πp and pp processes. The relation is in agreement with the available experimental data. (auth)

41955 ISOSPIN MIXING AS A SOURCE OF ENHANCED ISOSPIN VIOLATION IN πN SCATTERING. Toernqvist, N. A. (CERN, Geneva). Phys. Lett.; 40B: No. 1, 109-11(12 Jun 1972).

A small η impurity in π^0 can sometimes cause large deviations from isospin invariance in $\pi^- p \rightarrow \pi^0 n$, and could account for the observed experimental indications of violation of the backward isospin bounds below 1 GeV/c. Possible large effects of mixing between formed N*'s and Δ's are also briefly considered. (auth)

41956 RAPIDITY CORRELATIONS IN INCLUSIVE TWO PION PRODUCTION AND A MULTIPERIPHERAL–THERMODYNAMIC MODEL. Ranft, Gisela; Ranft, J. (Karl-Marx-Univ., Leipzig). Phys. Lett.; 40B: No. 1, 131-5(12 Jun 1972).

Inclusive two particle spectra and correlation functions are calculated from a multiperipheral-thermodynamic model. This model was previously proposed by the authors in order to derive the velocity weight function used in the thermodynamic description of single particle spectra from the multi Regge model. It was argued that the one-fireball graph dominates at accelerator energies. In this model two particle correlation functions are calculated without introducing new concepts or parameters. The results of the calculation are compared with recent data on inclusive $\pi^-\pi^-$ production in K^+p collisions at 12 GeV/c. Good agreement is found with the experimental correlation function plotted in terms of the rapidity difference $\Delta y^* = y_1^* - y_2^*$ of the two observed negative π mesons. (auth)

41957 REMARKS ON A PAPER BY WAYLAND. Cohen, J.; Friedlaender, E. M. (Inst. for Atomic Physics, Bucharest). Lett. Nuovo Cim.; 4: No. 5, 153-4(3 June 1972).

It was previously shown that the asymptotic expression used in deriving the transverse-momentum spectrum (a Γ distribution) from the thermodynamics of multiple-particle production may deviate considerably at low p_T from the given rigorous expression. A sensitive test was also previously described for the goodness of fit of any Γ distribution to transverse-momentum data. In order to check whether observed inconsistencies are not due to the previous approximation, the higher moments of the rigorous thermodynamic spectrum for the temperature ranging from 80 to 200 MeV were computed and are shown for $\pi^- + p$ interactions at 11 to 25 GeV. (J.F.P.)

41958 HELICITY CONSERVATION AT HIGH ENERGIES. Hara, Y. (Tokyo Univ. of Education). Lett. Nuovo Cim.; 4: No. 5, 157-60(3 Jun 1972).

The possibility of approximate s-channel helicity conservation in diffraction scattering and of approximate t-channel helicity conservation in diffractive production of unstable particles which decay dominantly into a pion and another particle is pointed out. From the amplitude of the $\pi + N \rightarrow A_1 + N$ interactions it is found that t-channel helicity is approximately conserved by bosons and that s-channel helicity is conserved by the nucleon in this reaction. From the amplitude the cross section for the reaction $\pi^- + p \rightarrow A_1^- + p$ is found in agreement with the experimental result. The amplitude is found for the $K + N \rightarrow Q + N$ interactions, and the cross section for the reaction $K^- + p \rightarrow Q^- + p$ is predicted. (J.F.P.)

41959 SU_3-SYMMETRY BREAKING AND SLOPES OF BARYON LINEAR TRAJECTORIES. Kanki, T. (Osaka Univ.). Lett. Nuovo Cim.; 4: No. 5, 165-8(3 Jun 1972).

For the baryon case the compatibility of the hypotheses that the dominant part of the hadron Regge trajectory function is linear in mass squared and that of the Gell-Mann–Okubo mass formula is discussed and compared with the experimental situation for octet and decuplet baryons. (J.F.P.)

41960 EXCHANGE DEGENERACY AND THE REACTION K^-p yields K^+XI^-. Saxena, A. B. (Allahabad Univ., India). Lett. Nuovo Cim.; 4: No. 5, 169-70(3 Jun 1972).

The consequence of exchange degeneracy with respect to polarization for the reaction $K^- + p \rightarrow K^+ + \Xi^-$ is studied. It is found that exchange degeneracy does not hold strictly. The small value of the polarization suggests intuitively that the violation of exchange degeneracy is not large and that the approximate energy dependence of the cross sections can be obtained from the contributions of the double Regge exchange diagrams. These cross sections are found to be roughly in agreement with experimental data. (J.F.P.)

41961 DYNAMICAL MODEL FOR THE πN RESONANCES $P_{13}(1860)$, $P_{31}(1910)$, AND $F_{35}(1890)$. Gustafson, Goesta (NORDITA, Copenhagen). Nucl. Phys.; B42: 205-22(1 Jun 1972).

Previously a model for the resonances $S_{31}(1650)$, $S_{11}(1700)$, and $D_{33}(1670)$, was presented in which these resonances were explained as a result of the interaction with the ρN system, where the ρ meson and the nucleon moved in a relative S state. The same model is applied to the case when the ρ meson and the nucleon are in a relative P state. Without any additional free parameter it is possible to explain the resonances $P_{13}(1860)$, $P_{31}(1910)$, and $F_{35}(1890)$ and to give good fits to the experimental phase shifts. (auth)

41962 DIFFRACTIVE AND ELASTIC INTERACTIONS IN K^+p SCATTERING BELOW 2.5 GeV/c. Kinoshita, Y. (Kinki Univ., Iizuka, Japan); Kinoshita, K. Nucl. Phys.; B42: 223-39(1 Jun 1972).

The K^+p scattering below 2.5 GeV/c is investigated by separating the full amplitude into pure elastic and channel-coupling terms. The diffractive property of the latter is found by considering a sort of random-phase approximation to it. Low-energy diffraction terms and empirical Born terms are computed from phase-shift data and their properties are examined. (auth)

41963 CHIRAL SYMMETRY BREAKING IN THE KAON–NUCLEON SYSTEM. Koepp, G. (Technische Hochschule, Aachen); Walsh, T. F.; Zerwas, P. Nucl. Phys.; B42: 109-24(1 Jun 1972).

The s-channel isospin-zero A-amplitude in off-mass-shell kaon-nucleon scattering is investigated at the crossing-symmetric point by evaluating a finite-energy sum rule. Assuming the $[(3,3^*) + (3^*,3)]$ chiral symmetry breaking model of Gell–Mann, Oakes and Renner, a small positive value is derived for the baryon matrix element of the SU(3) invariant part present in the chiral symmetry breaking density. (auth)

41964 K^+p AND K^-p ELASTIC SCATTERING AND TOTAL CROSS SECTIONS. Henzi, R.; Mackay, A.; Margolis, B.; Ross, W. A. (McGill Univ., Montreal). Phys. Rev., D; 5: No. 11, 2754-7(1 Jun 1972).

The results are presented of a fit of K^+p and K^-p total cross sections and elastic differential cross sections and polarizations, as well as a calculation of the ratios of the real to the imaginary part of the forward elastic scattering amplitudes using the Frautschi–Margolis Regge-eikonal model. The results of the fits, especially in large-angle K^-p scattering, present evidence for the validity of a multiple-scattering picture. (auth)

41965 AMBIGUITIES IN SCATTERING AMPLITUDES RESULTING FROM INSUFFICIENT EXPERIMENTAL DATA. Dean, N. W.; Lee, Ping (Iowa State Univ., Ames). Phys. Rev., D; 5: No. 11, 2741-6(1 Jun 1972).

A systematic study of the problem of reconstructing the scattering matrix from experimental data is presented. Insufficient data lead to ambiguities; a general technique for finding ambiguities is given. The cases of isospinless spin-0-spin-½ scattering (two amplitudes) and pion–nucleon scattering (four amplitudes) are treated in detail. The ambiguities present in both cases when the R and A parameters are unknown have a profound effect on partial-wave analysis, leading to confusion and misidentification of resonances. It is shown that only eight measurements are needed to reconstruct the pion–nucleon amplitudes, rather than nine as averred by Bilenkii and Ryndin. (auth)

41966 DUAL ABSORPTIVE MODEL AND STRUCTURE IN INELASTIC REACTIONS. Chen, Min-shih; Paige, Frank E. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 5: No. 11, 2760-2(1 Jun 1972).

The implications of a model for two-body scattering amplitudes combining duality and strong absorption are investigated for inelastic reactions. At $t = t_c$, where the imaginary part of the helicity-nonflip amplitude vanishes in the model, predictions about the real part can be made via fixed-t dispersion relations. Strong results can be thus obtained for amplitudes which are antisymmetric under $s \leftrightarrow u$ crossing. As examples, definite predictions on $\pi^- p \rightarrow \pi^0 n$ polarization and $K_L^0 p \rightarrow K_S^0 p$ differential cross section at $t = t_c$ are made. The general case without the $s \leftrightarrow u$ antisymmetry is also discussed. (auth)

41967 SEPARATION OF N AND Δ EXCHANGES IN πN SCATTERING AND DEDUCTION OF AMPLITUDE ZEROS. Barger, V.; Olsson, M. G. (Univ. of Wisconsin, Madison). Phys. Rev., D; 5: No. 11, 2736-40(1 Jun 1972).

Linear combinations of πN differential cross sections and polarizations are used to isolate the $I_u = 1/2$ and $I_u = 3/2$ exchange amplitudes directly from data. For $I_u = 1/2$ exchange the cross section has a zero at $u = -0.15$ (GeV/c)^2 and the polarization becomes large and negative for $|u| > 0.25$ (GeV/c)^2. The phenomenological analysis indicates that in the dip region the $I_u = 1/2$ amplitude is inconsistent with appreciable secondary trajectories or absorptive corrections. For $I_u = 3/2$ exchange it is inferred that the imaginary s-channel helicity-flip amplitude has a zero near $u = -0.15$ (GeV/c)^2, consistent with peripherality for Δ exchange. A sum rule relating the πN differential cross sections at 180° to the Regge-trajectory difference $\alpha_\Delta - \alpha_N$ is also derived. (auth)

41968 FINITE-ENERGY SUM RULES, REGGE CUTS, AND FORWARD πN CHARGE-EXCHANGE SCATTERING. Johnson, R. C. (Durham Univ., Eng.). Phys. Rev., D; 5: No. 11, 2768-73(1 Jun 1972).

Finite-energy sum rules (FESR) with logarithmic terms are formulated in a way amenable to simple and accurate approximation, thus allowing their convenient use in data fitting with Regge cuts. It is observed that a typical cut FESR contribution is similar to that of a pole lying perhaps half a unit lower in the J plane. Therefore $\rho + \rho'$ fits to $\pi^- p \rightarrow \pi^0 n$ seem to imply decoupling of the $\rho \otimes P$ Regge cut from the nonflip amplitude at $t = 0$. This is investigated in more detail, and its implications are pointed out. (auth)

41969 ELECTROMAGNETIC EXCITATIONS OF THE NUCLEON IN A RELATIVISTIC QUARK MODEL. Lipes, Richard G. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., D; 5: No. 11, 2849-63(1 Jun 1972).

A variation of the relativistic quark model of Feynman, Ravndal, and Kislinger is considered that admits spatial wave functions normalizable in all components of the relative variables. With these wave functions, the matrix elements of the hadronic electromagnetic current between the nucleon and excited states are calculated for final states up to 1700 MeV in mass. Very good agreement between the predicted elastic nucleon electromagnetic form factors and experiment is obtained. Cross sections for the electroproduction of nucleon resonances through the third resonance are derived and compared with experiment. A discussion of the consistency and limitations of the model is presented. (auth)

41970 APPLICATION OF THE NEW INTERFERENCE MODEL TO THE MESON–BARYON HYPERCHARGE-EXCHANGE REACTIONS. Kumar, Raj; Agarwal, B. K. (Allahabad Univ., India). Phys. Rev., D; 5: No. 11, 2835-46(1 Jun 1972).

The hypercharge-exchange reactions $K^- n \rightarrow \pi^- \Lambda^0$, $K^- p \rightarrow \pi^0 \Lambda^0$, $\pi^- p \rightarrow K^0 \Lambda^0$, $K^- n \rightarrow \pi^- \Sigma^0$, $K^- p \rightarrow \pi^- \Sigma^+$, $\pi^- p \rightarrow K^0 \Sigma^0$, and $\pi^+ p \rightarrow K^+ \Sigma^+$ are studied within the framework of the new interference model. It is found that the differential cross section and polarization can be predicted in reasonable agreement with experiments in the intermediate momentum range. (auth)

41971 DISPERSION RELATIONS IN THE TRANSVERSE MOMENTUM FOR FIXED s. Yu, Wing-yin; Moravcsik, M. J. (Univ. of Oregon, Eugene). Lett. Nuovo Cim.; 4: No. 6, 228-32(10 Jun 1972).

The dispersion relations in the transverse momentum are derived from fixed-s dispersion relations in t. The case of spinless particles is taken. Pion and rho production in N + N and π + N inclusive interactions is considered. (J.F.P.)

41972 SYMMETRY-POINT SUM RULES AND REACTION $\pi^- p \rightarrow \eta n$. Ahmad, M. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 4: No. 6, 237-40 (10 Jun 1972).

The symmetry-point dispersion sum rules are applied to the reaction $\pi^- + p \rightarrow \eta + n$, and the ηNN coupling constant is determined using available experimental data on baryon resonances, decay widths, and A_2NN coupling constants. (J.F.P.)

41973 ABSORPTIVE SEPARABLE POTENTIALS CONSTRUCTED FROM πN DATA. Landau, Rubin H.; Tabakin, Frank (Univ. of Pittsburgh). Phys. Rev., D; 5: No. 11, 2746-54(1 Jun 1972).

A simple method for constructing an absorptive (complex) separable potential directly from the πN phase shifts and absorption parameters is presented. This permits the transition matrix to be calculated both on and off the energy shell as required in the calculation of the π-nucleus optical potential. The solution of the inverse scattering problem presented here is an extension of a previous solution to include absorption, when the phase shifts are complex, and relativistic kinematics. The potentials for all S- and P-wave πN eigenchannels are constructed and displayed. The construction of a complex separable potential is also applicable to other systems such as NN, ΛN, and KN. (auth)

41974 DUALITY AND THE DECK EFFECT. Frampton, P. H.; Toernqvist, N. A. (CERN, Geneva). Lett. Nuovo Cim.; 4: No. 6, 233-6(10 Jun 1972).

Using the five-point amplitude of the generalized Veneziano model a clarification is made of criticism of the conjecture that the Deck effect and a true resonance are different manifestations of the same phenomena; namely, that duality is applicable only to the imaginary part and not to the full amplitude and that the Deck effect is essentially of kinematic origin and should appear for any amplitude with appropriate peripheral properties independently of whether there are resonance poles in the Deck variable. The reactions $K^+ + p \rightarrow \pi^+ + K^+ + n$ at 10 GeV/c and $\pi + N \rightarrow 2\pi + N$ at 10 to 30 GeV/c are considered. (J.F.P.)

41975 CALCULATION OF THE $\rho\rho$P TRIPLE-REGGE VERTEX FROM TWO-BODY SCATTERING DATA ASSUMING DUALITY AND AN f-COUPLED POMERON. Balazs, L. A. P. (Purdue Univ., Lafayette, Ind.). Phys. Lett.; 40B: No. 2, 269-71(26 Jun 1972).

The $\rho\rho$ f triple-Regge vertex is calculated in terms of the $\pi\pi \rightarrow \pi\pi$ amplitude through inclusive finite-energy sum rules for $\pi\pi \rightarrow \pi X$. It is then related to the $\rho\rho$ P vertex by assuming a generalized version of the f-coupled Pomeron hypothesis. (auth)

41976 PION–NUCLEON SCATTERING AMPLITUDES AT 6 GeV/c AND 16 GeV/c. Cozzika, G.; Ducros, Y.; Gaidot, A.; (and others) (CEN, Saclay, France). Phys. Lett.; 40B: No. 2, 281-4(26 Jun 1972).

The helicity amplitudes are determined at 6 GeV/c, for both isospin $I = 0$ and $I = 1$ states in the crossed channel. The analysis is extended to the interval from $t = 0$ to $t = -1.0$ (GeV/c)^2. At 16 GeV/c, the number of independent experiments is still insufficient. Only the amplitudes for $I = 0$ exchange are calculated, in the interval from $t = 0$ to $t = -0.5$ (GeV/c)^2. (auth)

41977 CALCULATION OF INCLUSIVE SPECTRA $K^+ p \rightarrow K^0$ + ANYTHING AND $K^- p \rightarrow \overline{K}^0$ + ANYTHING ACCORDING TO THE THERMODYNAMIC MODEL. Matthaeus, E.; Ranft, J. (Karl-Marx-Univ., Leipzig). Phys. Lett.; 40B: No. 2, 230-4(26 Jun 1972).

A comparison of the thermodynamic model of multiparticle production with experimental data $K^+ p \rightarrow K^0$ + anything and $K^- + p \rightarrow \overline{K}^0$ + anything at 8.2 and 10.1 GeV/c is reported. Using the same velocity weight function $F_0(\lambda)$ for through-going particles as determined from inclusive single particle spectra in p–p collisions a remarkable agreement of the thermodynamic K^0-spectra is found with data in the fragmentation region and with respect to the missing mass dependence of the momentum transfer distributions. It is furthermore found that with respect to the production of through-going particles the isospin is conserved as locally as baryon number and strangeness. This behavior explains the observation that the majority of the K^0 in the fragmentation region is produced via resonances. (auth)

41978 TWO PARTICLE CORRELATIONS IN INCLUSIVE REACTIONS AND BOUNDARY CONDITIONS: HOW TO INCORPORATE ENERGY AND MOMENTUM CONSERVATION IN FACTORIZATION TESTS. Beaupre, J. V. (Technische Hochschule, Aachen). Phys. Lett.; 40B: No. 2, 225-6(26 Jun 1972).

It is shown that the usual two particle longitudinal variable correlation function does not test factorization of the two particle inclusive structure function because boundary conditions—energy and momentum conservation—are ignored in the usual formulation. At high energies the effect of the boundary is of order 1 for Feynman variables and of order $1/\ln s$ for rapidities, while the approach to factorization is thought to be $1/\sqrt{s}$. A new correlation function which removes these boundary effects is proposed. (auth)

41979 SYMMETRIES OF REGGE–REGGE CUTS. Worden, R. P. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Lett.; 40B: No. 2, 260-4(26 Jun 1972).

Regge–Regge cuts are shown to satisfy strong symmetry constraints in any model which incorporates Finkelstein's cut selection rule, SU(3) symmetry of Regge residues, and exchange degeneracy of trajectories and residues. These imply, among other things, the strong suppression of Regge–Regge cuts in pion–nucleon charge exchange, arising from a cancellation between ρ-P' and A_2-ω cuts. Therefore if Finkelstein's selection rule is valid the πN charge exchange amplitudes cannot be understood by adding Regge–Regge cuts to an absorbed ρ pole amplitude. (auth)

41980 MULTIRESONANCE MODEL FOR HIGH-ENERGY HADRON PRODUCTION. Satz, H.; Thomas, G. H. (Univ. of Helsinki). Nuovo Cim.; 9A: No. 4, 433-49(21 Jun 1972).

The multiperipheral model is generalized to include resonance behavior in low-mass two-body subsystems, avoiding simultaneous resonances in adjacent (dual) subenergies. The essential features of the proposed parametrization are compared with previous theoretical (CŁA, dual resonance) work and with experimental results. (auth)

41981 DIFFERENTIAL CROSS-SECTIONS FOR CHARGE EXCHANGE: REACTIONS WITH t-DEPENDENT RESIDUES. Delbourgo, R.; Rotelli, P. (Imperial Coll. of Science and Tech., London). Nuovo Cim.; 9A: No. 4, 504-14(21 Jun 1972).

A model incorporating biquark and triquark Regge propagators in Reggeized supermultiplet theory is applied to some of the highest-energy meson-baryon charge-exchange data available. The fits are good within the limitations of the model and the standards prevalent in this field of phenomenology. Renormalization of some of the theoretical amplitudes improves the fits and indicates SU_3 and SU_6 breaking of about 10% in the residues. (auth)

41982 PARTIAL-WAVE AMPLITUDES IN π^-N CHARGE EXCHANGE AT 6 GeV/c. Hoegaasen, H. Paris Univ., Orsay, France. Univ. of Oslo). Phys. Norv.; 5: No. 3-4, 219-24(1971).

From amplitudes for forward πN charge-exchange scattering the partial waves are found and compared with expectations from Regge and geometrical approaches to π-meson exchange. (auth)

41983 NEW DISPERSION RELATION FOR KAON–NUCLEON SCATTERING. I. CONSTANT SCATTERING LENGTH PARAMETRIZATION OF THE LOW-ENERGY REGION. Conti, A. (Univ., Lecce, Italy). Nucl. Phys.; B42: 607-19(1 Jun 1972).

A modified forward dispersion relation for KN scattering is proposed which is more suitable than the conventional conjugate Hilbert transform because it exhibits a more convergent form. Using the constant scattering length parametrization of the low-energy data a fairly good consistency for the $K^{\pm}p$ process is found. (auth)

41984 EFFECTIVE RANGE FORMULAE FOR N_{33}. Lea, A. T. (Rutherford High Energy Lab., Berks, Eng.); Hamilton, J. Nucl. Phys.; B42: 518-40(1 Jun 1972).

The difficulties of fitting the left hand singularities of the πN P_{33} amplitude by using some simple algebraic forms are illustrated. The alternate method of using almost unitary functions is studied. It is shown to give bounds on the energy of the resonance N^*_{33}. A reasonably good solution is given by an improved method where the deviations from unitarity are forced to be especially small in the resonance region. (auth)

41985 SOLUTION OF THE DISPERSION RELATIONS FOR THE πN-SCATTERING AMPLITUDES BY THE METHOD OF PADE APPROXIMANTS. Fil'kov, L. V.; Palyushev, B. B. (Lebedev Inst. of Physics, Moscow). Nucl. Phys.; B42: 541-57 (1 Jun 1972).

The [1,1] Padé approximant is used in order to obtain a solution of the dispersion relations for the πN-scattering amplitude. The dispersion relations are constructed with one subtraction for the amplitude $A^{(+)}$ and without subtraction for all the other amplitudes. There is one free parameter (β) only, connected with the t-channel contribution. The results obtained for s, p and d waves with isospins $T = 1/2$ and $T = 3/2$ are in satisfactory agreement with experiment in quite a large energy region (except the P_{13} wave). The results of the calculations do not change very much if one neglects the contribution of the t-channel ($\beta = 0$). The partial $S^{(2t)}_{l\pm\frac{1}{2}}$ matrix analysis in the region below the threshold of πN-scattering indicates the existence of antibound states in the P_{33} wave with effective masses of 900 and 955 MeV and in the P_{11} wave with an effective mass of 1010 MeV. (auth)

41986 PHASE SHIFT ANALYSES OF THE K^+–NUCLEON INTERACTION IN THE I equals O STATE UP TO 1.5 GeV/c. Bologna-Glasgow-Rome-Trieste Collaboration. Nucl. Phys.; B42: 445-53(1 Jun 1972).

Energy-dependent and energy-independent phase shift analyses which have been carried out for the I = 0 state in K^+N scattering are described. The energy-dependent analysis covers the momentum range 0.60 to 1.50 GeV/c while the energy-independent covers the range 0.37 to 0.98 GeV/c. The two preferred solutions of the energy-dependent analysis show a counterclockwise circle in the $P_{\frac{1}{2}}$ amplitude with the maximum around 1 GeV/c (auth)

41987 EXCHANGE INTERFERENCE EFFECT ON $\mathrm{Re}\rho_{10}$ IN K^* PRODUCTION. Barmawi, M. (International Centre for Theoretical Physics, Trieste, Italy). Nucl. Phys.; B42: 620-6 (1 Jun 1972).

The interference between exchanges, in vector meson production, that can contribute to $\mathrm{Re}\rho_{10}$ are: (i) interference between unnatural parity exchanges with the same CP quantum numbers, (ii) interference between exchanges of natural parity and those of unnatural parity with CP = +1. The application of this property and line reversal to K^* production data on $\mathrm{Re}\rho_{10}$ gives an indication of possible unnatural parity exchange with CP = +1 and C = −1, in addition to the π-B and π-H interferences. Features and distinction of these models are discussed. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 42115.

41988 (JINR-P1-6339) ELASTIC N–N SCATTERING MATRIX AT 630 MeV. 1. PHASE-SHIFT ANALYSIS OF p–p SCATTERING. Glonti, L. N.; Kazarinov, Yu. M.; Kiselev, V. S.; Silin, I. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Apr 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

The phase-shift analysis of pp-scattering at $l_{max} = 6$ was performed. Two solutions were obtained ($\chi^2 = 246.6$ and 278.0 at 239 degrees of freedom). The stability of the obtained set was studied in transition from $l_{max} = 6$ to $l_{max} = 5$. The data on pp-scattering, used in the phase-shift analysis, are listed. (auth)

41989 (JINR-P1-6387) MATRIX OF ELASTIC N–N SCATTERING AT 630 MeV. II. PHASE-SHIFT ANALYSIS OF N–N SCATTERING. Glonti, L. N.; Kazarinov, Yu. M.; Kiselev, V. S.; Silin, I. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Apr 1972. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

Based on the results of the previously performed phase-shift analysis of p-p scattering at 630 MeV the phase-shift analysis of N–N scattering data was performed. It is shown that transfer from $l_{max} = 5$ (at which the previous phase-shift analysis was performed) to $l_{max} = 6$ does not improve considerably the description of experimental data. In the case of using the τ-criterion the analysis is considered to be unique with the first order error probability less than 1%. The list of experimental data on np-scattering near 630 MeV is presented. (auth)

41990 (JINR-P2-6325) MECHANISM OF DEUTERON PRODUCTION IN INTERACTION OF 670-MeV PROTONS WITH NUCLEI. Dal'karov, O. D.; Ngo Quang Zui (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Mar 1972. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that the momentum spectra of deuterons (from 700 GeV/c to 1400 MeV/c), produced at angles of ≤16° in the interaction of 670 MeV protons with nuclei, can be described by the $A(p,d_\pi)$ B reaction channel. In the calculations the effect of rescattering of π-mesons, produced in the reaction $p + N \rightarrow d + \pi$ on residual nucleus, was taken into account. (auth)

41991 MOMENTUM TRANSFER DEPENDENCE IN DIFFRACTION DISSOCIATION. Miettinen, H. I. (Rutherford High Energy Lab., Chilton, Eng.); Pirilae, P. Phys. Lett.; 40B: No. 1, 127-30 (12 Jun 1972).

The mechanism of kinematic coupling between momentum transfers in producing a low mass two particle system with double-peripheral dynamics is studied theoretically and with model calculations. A method of data analysis which eliminates the effects of this kinematic reflection is presented. The data of the reaction $pp \rightarrow pn\pi^+$ at 19 GeV/c have been analyzed using this method. It is seen that the high production slope of the low mass $n\pi^+$ system observed in this process is not a consequence of double-peripheral dynamics plus kinematics but must be explicitly present in the invariant matrix element. (auth)

41992 ISOSPIN AND SU_3 EQUALITIES FOR STRONG, ELECTROMAGNETIC AND WEAK INCLUSIVE PROCESSES. Macfarlane, A. J. (Northern Illinois Univ., Dekalb. Argonne National Lab., Ill.). Lett. Nuovo Cim.; 4: No. 5, 186-90(3 Jun 1972).

An explicit proof of a maximum complexity theorem used by Lipkin and Peshkin for isospin conserving inclusive hadronic processes is given. The extension to photoproduction, neutrino and antineutrino production of hadrons, electroproduction, electron–positron annihilation into hadrons, and SU(3) is made evident and illustrated by the derivation of equalities for cross sections for each of these processes. (J.F.P.)

41993 RELATIVISTIC DEUTERON WAVE FUNCTION. Remler, E. A. (Coll. of William and Mary, Williamsburg, Va.). Nucl. Phys.; B42: 56-68(1 Jun 1972).

Using ideas contained in work by Blankenbecler and Sugar, and Gross, a practical theory of the relativistic deuteron wave function is developed. The correspondence with the nonrelativistic wave function is made. The normalization condition and relativistic wave equation is derived. Negative energy contributions are emphasized. (auth)

41994 RELATIVISTIC NUCLEON–DEUTERON EXCHANGE SCATTERING. Remler, E. A. (Coll. of William and Mary, Williamsburg, Va.). Nucl. Phys.; B42: 69-76(1 Jun 1972).

Relativistic corrections to the one-nucleon-exchange contribution to elastic nucleon-deuteron scattering which are usually overlooked are discussed. Given the present state of knowledge of the deuteron vertex, their importance, except at the very lowest energies, is an open question. (auth)

41995 PRODUCED PARTICLE FLUXES AT VERY HIGH ENERGIES. Arnold, Richard C.; Berger, Edmond L. (Argonne National Lab., Ill.). Phys. Rev., D; 5: No. 11, 2733-6(1 Jun 1972).

A conjecture, motivated by dual-resonance models and scaling laws, is presented which simply relates the production rates for various particles in the central region, at limiting high energies. At zero c.m. longitudinal momentum ($x = 0$) and zero transverse momentum, the kaon/pion ratio is predicted to be of order 0.02. An operational definition is proposed for the term "central region;" it is used subsequently to determine the energy region of applicability of our predictions. The results given here may be useful for estimating secondary particle yields at the CERN Intersecting Storage Rings and the National Accelerator Laboratory. (auth)

41996 LOW-ENERGY Σ^-d SCATTERING. Schick, L. H.; Damle, P. S. (Univ. of Wyoming, Laramie). Phys. Rev., D; 5: No. 11,2773-80(1 Jun 1972).

A Faddeev formalism and two-body, S-wave, central separable potentials to calculate Σ^-d quartet elastic and reaction cross sections for Σ^- incident lab momentum in the range 30 to 90 MeV/c. A three-channel isospin-½ hyperon-nucleon potential with a Λn resonance below the Σ^0n threshold, but in the three-body calculation the Λn channel is only included implicitly. It is found that Σ^-d cross sections are sensitive to the size of the Σ^-p scattering length, but insensitive to the exact position and width of the Λn resonance. (auth)

41997 ΛN TWO-CHANNEL $^3S_1-^3D_1$ SEPARABLE POTENTIAL. Russell, R.; Schick, L. H. (Univ. of Wyoming, Laramie). Phys. Rev., D; 5: No. 11, 2804-10(1 Jun 1972).

A simple form of a two-channel nonlocal separable potential which includes a tensor term is adjusted to fit the ΛN scattering lengths and effective ranges given by a specific meson-theoretic potential for various combinations of ΣN channel and tensor force suppression. For Yamaguchi potential shapes it is shown that such a fit may be obtained only for severely restricted values of the ΛN-channel range parameters. The further requirement of the existence of a resonance which is not due to a bound state in the uncoupled ΣN channel could only be met for some of the fits so obtained. (auth)

41998 SPECTRAL REPRESENTATIONS AND THEIR APPLICATION TO INCLUSIVE PROCESSES. Cornwall, John M. (Univ. of California, Los Angeles). Phys. Rev., D; 5: No. 11, 2868-77 (1 Jun 1972).

A representation is given for the product of two currents sandwiched between two-particle states, similar to the Deser–Gilbert–Sudarshan representation of commutators. In this case, arguments based on causality are not available for the two-particle matrix element. It is shown that in the process $pp \rightarrow \mu^+\mu^- +$ anything, the cross section cannot decrease rapidly in $q_\perp$ (the perpendicular momentum transfer) for $q_\perp^2 \ll q^2$ (q is the $\mu^+\mu^-$ momentum), unless it decreases extremely rapidly in q^2. An application of the free-quark model to the product of two pion currents yields Feynman scaling for the process $pp \rightarrow \pi +$ anything, when proper account is taken of the rapid decrease in $q_\perp$ of this cross section. (auth)

41999 INELASTIC SCATTERING FROM DEUTERIUM IN THE IMPULSE APPROXIMATION. Dean, N. W. (Iowa State Univ., Ames). Phys. Rev., D; 5: No. 11, 2832-5(1 Jun 1972).

The differential cross sections for arbitrary processes ad → bpp and ad → b′pn are evaluated in detail in the impulse approximation, with spin and isospin effects and the deuteron D state properly included. Approximations valid when a single term of the free-nucleon amplitude dominates are given. (auth)

42000 MASSIVE MUON PAIR PRODUCTION IN HADRON–HADRON COLLISIONS. Derman, Emanuel (Columbia Univ., New York). Phys. Rev., D; 5: No. 11, 2810-14(1 Jun 1972).

A simple field-theoretic model with no ad hoc cutoff is used to obtain an explicit expression to low order in perturbation theory for the cross section for producing a massive muon pair in high-energy proton–neutron collisions. This model provides a specific example of the relation between this process and deep-inelastic electron-nucleon scattering derived by Drell and Yan. (auth)

42001 IONIZATION CALORIMETER (CALCULATIONS AND EXPERIMENT). Morozov, A. E.; Slavatinskii, S. A.; Fetisov, I. N. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2022-8(Oct 1971). (In Russian).

The Monte-Carlo method was used to calculate the continual development of nucleus-electron cascades in an ionization calorimeter for the original nucleon and pions with energies of 300, 600, and 1,360 GeV. Various characteristics of the computed cascades (average fluctuation and correlation) were in good agreement with the experiment. The design characteristics of the calorimeter (corrections and errors in energy determination), and their dependence on initial energy, absorber thickness, number of arrays, and the sensitivity of the ionization chamber were calculated. (tr-auth)

42002 ITERATIVE DETERMINATION OF ANALYTIC CONTINUATION AND ITS APPLICATION TO THE pp FORWARD AMPLITUDE. Kanazawa, A.; Sugawara, M. (Purdue Univ., Lafayette, Ind.). Phys. Lett.; 40B: No. 2, 265-8(26 Jun 1972).

A report is made on a new attempt to determine analytic continuation of scattering amplitudes, which consists of evaluating iteratively on a computer the usual dispersion relation and its inverted one. Its application to the pp forward amplitude shows that this method is practical and powerful. Its imaginary part is shown to have a large dip just above the $p\bar{p}$ threshold, which makes its high-energy real part nearly twice that determined experimentally ignoring spin-flip. (auth)

42003 N–N INTERACTION FROM LAGRANGIAN FIELD THEORY. Bessis, D.; Turchetti, G.; Wortman, W. R. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Lett.; 39B: No. 5, 601-4 (29 May 1972).

Nucleon–nucleon phase shifts are calculated by using the results of the perturbation expansion of two Lagrangian field theories, the Yukawa model and the nonlinear sigma model. For this purpose the [1,1] Padé approximant to a submatrix of the 16×16 spin matrix is taken which eliminates the problem of anomalous threshold behavior. A dramatic improvement relative to the scalar method is found and this eliminates the $^1D_2$ and $^1G_4$ resonances while providing reasonable low energy behavior for the S waves and inversion of the $^3P_0$ phase shift. (auth)

42004 SPIN-ORBIT COUPLING FOR $\Lambda-{}^4$He SCATTERING USING A ONE-BOSON-EXCHANGE MODEL FOR THE ΛN INTERACTION. II. Londergan, J. T. (Case Western Reserve Univ., Cleveland. Indiana Univ., Bloomington); Dalitz, R. H. Phys. Rev., C; 6: No. 1, 76-86(Jul 1972).

The polarization $P_\Lambda(\theta)$ and differential cross section $d\sigma/d\Omega$ for $\Lambda-{}^4$He scattering are calculated for Λ incident energies 5–20 MeV, for the $\Lambda-{}^4$He spin-orbit potentials V_{LS} derived from several one-boson-exchange models given for the ΛN interaction in the literature. The $\Lambda-{}^4$He central potential used depends on the intrinsic range b for the ΛN potential; our knowledge of this parameter is reviewed, and the estimate $b = 2.0 \pm 0.3$ fm is obtained for a Gaussian shape from a simplified analysis of the low-energy ΛN cross-section data. The effect of V_{LS} of a cutoff in the ΛN spin-orbit potential for distances $\gamma_{\Lambda N} \leq d$ is discussed and compared with the regularization adopted in the earlier paper. $P_\Lambda(\theta)$ and $d\sigma/d\Omega$ for the modified V_{LS} with $d = 0.4$ fm are compared with those for the case $d = 0$; the sensitivity of the largest p-wave phase shift and of $P_\Lambda(\theta)$ to the intrinsic range b is also indicated. The relation between these V_{LS} calculations and the effect of ΛN spin-orbit forces in the shell-model analysis of the Λ separation energies for the p-shell Λ hypernuclei is discussed; since the latter prefers V_{LS} with sign opposite that calculated here, $P_\Lambda(\theta)$ has been calculated also for the spin-orbit potential ($-V_{LS}$) to illustrate that the sign appropriate for the ΛN spin-orbit interaction could be settled by even rough measurements over wide energy and angular intervals in this low-energy region. (auth)

42005 STRONG INTERACTION QUADRUPOLE EFFECTS IN PIONIC AND KAONIC ATOMS. Scheck, F. (SIN, Zurich. ETH, Zurich). Nucl. Phys.; B42: 573-88(1 Jun 1972).

The static quadrupole hyperfine structure in pionic and kaonic atoms with nuclear spin $J \geq 1$. The non-spherical contributions of the strong interaction lead to variations of shifts and widths among individual hyperfine components which should be measurable in favorable cases. For nuclei with quadrupole deformation the strong interaction quadrupole pattern is shown to depend on two parameters only (quadrupole shift and width). These strong interaction quadrupole constants contain new information on the nuclear mass quadrupole density in a fairly model-independent way. Numerical results for selected nuclei are given, corrections and possible ways of analyzing experimental data are discussed. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 41849, 42029, and 42043.

42006 CP NONINVARIANCE AND CHARGE ASYMMETRY OF THE UNIVERSE. **Kuz'min, V. A. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 2088-91(Oct 1971). (In Russian).**

An interaction model was constructed which did not conserve the baryon number, but conserved, through a weak current, the CP-nonconserving mixture. The latter had the same value as in an ultra-weak interaction. The existence of a new particle κ was postulated which was a true neutral fermion. Charge asymmetry during decay of κ resulted in baryon asymmetry of the universe, during which the asymmetry generated coincides with that of the value observed. (tr-auth)

42007 CONFORMAL SYMMETRY AND REVERBERATIONS. **Hortacsu, M.; Seiler, R.; Schroer, B. (Univ. of Pittsburgh). Phys. Rev., D; 5: No. 10, 2519-34(15 May 1972).**

It is shown that the operator conformal invariance breaks down for zero-mass fields unless they are free fields in even space-time dimension. This phenomenon is linked to the occurrence of "reverberations." This leads to the concept of weak conformal symmetry. In theories with anomalous dimensions reverberations are present and weak conformal invariance can be maintained. (auth)

42008 GENERALIZED GOLDSTONE THEOREMS IN AN EFFECTIVE-LAGRANGIAN FRAMEWORK. **Palmer, William F. (Ohio State Univ., Columbus). Phys. Rev., D; 5: No. 10, 2542-5 (15 May 1972).**

A set of sum rules among coupling tensors of different rank is derived for spontaneously broken continuous symmetries in an effective-Lagrangian framework. The sum rules, among which is the Goldstone theorem, constitute in this framework the physical content of that part of the spontaneously broken symmetry not contained in the conventionally realized subgroup which leaves the vacuum invariant, the latter subsymmetry manifesting itself in Wigner–Eckart relations among coupling tensors of the same rank. (auth)

42009 IDENTICAL PARTICLES, CROSSING, AND CPT. **Csonka, Paul L.; Moravcsik, Michael J. (Univ. of Oregon, Eugene). Phys. Rev., D; 5: No. 10, 2546-7(15 May 1972).**

It is shown that if crossing is a valid operation, and if identical quantum-mechanical particles are really indistinguishable, then the reaction $A + \bar{B} \to \bar{A} + B$ is CPT-invariant. Consequently, (a) there is no model-independent test of TCP invariance which can be carried out on one single reaction; (b) there is no model-independent way at all to distinguish between TCP conservation and total TCP violation (except possibly certain interference experiments); (c) no "violation of statistics" can be expected in the reaction $A + A \to B + B$ if the reaction $A + \bar{B} \to \bar{A} + B$ is CPT-invariant. (auth)

42010 DIRAC-LIKE GENERATORS OF THE INHOMOGENEOUS LORENTZ GROUP. **Kolsrud, M. (Univ. of Oslo). Phys. Norv.; 5: No. 3-4, 169-76(1971).**

Hermitean generators of the inhomogeneous Lorentz group are given, which for spin $\frac{1}{2}$ coincide with the Dirac generators. A Dirac-like equation for particles with arbitrary spin is included. Several relations from the spin $\frac{1}{2}$ case are generalized, keeping the same form as in this case. By a unitary transformation the canonical (Foldy-) generators are obtained. Tensor and pseudovector operators for spin in the laboratory system are deduced. The Lorentz transformation of the state function is in general nonlocal. (auth)

42011 IS A q-NUMBER δ REQUIRED IN (8,8) CHIRAL SYMMETRY BREAKING. Genz, H. (Univ., Karlsruhe, Ger.); Handschig, G.; Katz, J. Nucl. Phys.; B42: 454-60(1 Jun 1972).

The assumption that δ (the chiral-invariant scale-breaking part of the Hamiltonian density) has a dimension in the (8,8) model of chiral symmetry breaking is investigated. Using a spectral function sum rule for the vacuum expectation value of the chiral symmetry breaking Hamiltonian density u(x), restrictions for the mass m_ϵ and the width Γ_ϵ of $\eta_{0+}(700-1000)$ are derived from this assumption. They imply that a q-number δ with dimension $l_\delta \geq 1$ is incompatible with $\Gamma_\epsilon \leq m_\epsilon$ and $m_\epsilon \geq 600$ MeV. On the other hand, if δ is a c-number ($l_\delta = 0$) it is shown that $\Gamma_\epsilon \leq m_\epsilon$ is incompatible with $m_\epsilon \geq 690$ MeV while if Γ_ϵ is below m_ϵ (e.g. $\Gamma_\epsilon \leq 0.9\ m_\epsilon$) only an ϵ with a lower mass ($m_\epsilon \leq 670$ MeV) is allowed. The present phenomenological situation concerning ϵ makes impossible a definite conclusion on the dimensional content of δ in the (8,8) model. However, experiments favor values of m_ϵ and Γ_ϵ which imply that δ is a q-number consisting of at least two terms with different dimensions and nonvanishing vacuum expectation values. Quite generally, the results may be used to check if a particular theoretical prediction for m_ϵ and for Γ_ϵ is compatible with a c-number δ in the (8,8) model. It is assumed that u has a dimension and that conventional ϵ-saturation is valid. However, independent of the latter assumption it is shown here that in the (8,8) chiral symmetry breaking scheme the dimension of u is between 0 and 4 if δ is a c-number (this may also be seen in the $(\bar{3},3) \oplus (3,\bar{3})$ model from the analogous sum rule). (auth)

42012 CP VIOLATION: EXPERIMENTAL STATUS. **Cronin, Jack W. (Univ. of Chicago). pp 80-146 of Proceedings of the Fourth Hawaii Topical Conference in Particle Physics. /Yount, D. E. (ed.). Honolulu, Hawaii; Univ. of Hawaii Press (1972).**

From fourth topical conference in particle physics; Honolulu, HI. (2 Aug 1971). See CONF-710819.

Experimental evidence of CP violation outside the neutral K system and that concerning the neutral K system is reviewed. (J.F.P.)

Applications (Electromagnetic and Weak)

Refer also to abstracts 41769 and 41992.

42013 CP VIOLATION AND CHIRAL SYMMETRY. Schechter, J.; Ueda, Y. (Syracuse Univ., N. Y.). Phys. Rev., D; 5: No. 11, 2821-8(1 Jun 1972).

CP-violation terms belonging to the $(3,3^*)$ and $(3^*,3)$ chiral representations are discussed with the help of a general form of the SU(3) σ model. The formalism is developed for calculation with such terms and numerical estimates are then made. It is noted that the electric dipole moment of the neutron may be calculated very simply in this approach and the results show that models of this type are unlikely. The question of spontaneous breakdown of CP invariance is also discussed. An an aside it is shown that both CP-violating and CP-conserving $|\Delta S| = 1$ terms of the "$(3,3^*)$" type do not contribute to nonleptonic decays. Thus the so-called tadpole corrections to hyperon decays really vanish. (auth)

42014 POSSIBLE ORIGIN FOR SYMMETRY BREAKING. Schechter, J.; Ueda, Y. (Syracuse Univ., N. Y.). Phys. Rev., D; 5: No. 11, 2846-8(1 Jun 1972).

It is conjectured that the total Lagrangian of strong, electromagnetic, and weak interactions is invariant under the "left-handed SU(2)" of the weak currents, which is however spontaneously broken. A formula for the "tadpole" part of the K-meson electromagnetic mass splitting is discussed, which may be related to the present scheme. (auth)

42015 TWO-VARIABLE EXPANSIONS AND THE $K \to 3\pi$ DECAYS. Hicks, H. R. (Carnegie-Mellon Univ., Pittsburgh); Winternitz, P. Phys. Rev., D; 5: No. 11, 2877-89(1 Jun 1972).

Previously suggested two-variable expansions of three-body decay amplitudes in terms of harmonic functions of an O(4) group are discussed and applied to analyze the Dalitz-plot distribution of over 3.2 million $K^{\pm} \to \pi^{\pm}\pi^{\pm}\pi^{\mp}$ decay events. Among the general features of the O(4) expansions it is stressed that they are written in the c.m. system of two of the final particles, the angular momentum of which is displayed explicitly, and that each term in the expansion has a good behavior at the threshold, pseudothreshold, and at the boundary of the physical region. The recent data of Ford et al. on charged $K \to 3\pi$ decays are analyzed, using both O(4) expansion and the standard power-series expansion in terms of the Dalitz–Fabri variables. In both cases it is perfectly adequate to keep four terms in the corresponding expansion. The χ^2 fit is marginally better for the O(4) expansion. It is concluded that the $K \to 3\pi$ Dalitz plot has too little structure in it to provide a real test of the advantages or disadvantages of different treatments. It is thus most desirable to apply the O(4) expansions to Dalitz plots of other processes, like $\eta \to 3\pi$ or $\bar{p}n \to \pi\pi\pi$. No conclusive evidence is found for CP violation. However, the "linear" term in the O(4) expansion of the difference between the squared matrix elements for K^+ and K^- decays does differ from zero by more than two standard deviations. The effect is stable with regard to the number of terms kept in the expansions. An important distinctive feature of the O(4) expansions is their intimate relation to two-variable O(3,1) expansions of physical scattering amplitudes. (auth)

42016 SEARCH FOR A CP-NONCONSERVING ASYMMETRY IN THE DECAY $K_L^0 \rightarrow \pi^+\pi^-\pi^0$. Levit, Lawrence Bruce. Cleveland; Case Western Reserve Univ. (1971). 95p. University Microfilms Order No. 71-22,815.

Thesis.

The purpose of this experiment was to test CP symmetry in the decay $K_L^0 \rightarrow \pi^+\pi^-\pi^0$. A search was made for a charge asymmetry revealing itself as a difference between the π^+ and π^- transverse momentum spectra. The experimental configuration was three hodoscopes in line and a momentum analyzing magnet. The experimental limit set by this experiment was calculated from the data for which both charged π mesons were detected, and one x-ray from the π^0 decay was identified. This constitutes 400,000 events. The experimental data were analyzed by a Monte Carlo fitting procedure. The best value obtained for the CP violating parameter, $\sigma\pm$, was 0.0001 ± 0.0009. Estimates of all biases that could mask the asymmetry are included in the uncertainty quoted above. Two previous experiments have shown no asymmetry to a precision of 0.02, and one experiment exhibited a $2\frac{1}{2}$ standard deviation effect of 0.04. The result of this experiment is consistent with CP invariance. (Diss. Abstr. Int., B)

Applications (Strong)

42017 NATURE OF THE BREAKING OF CHIRAL AND SCALE SYMMETRIES AND THE $\eta' \rightarrow \eta\pi\pi$ DECAY. Chhajlany, S. C. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., D; 5: No. 11, 2896-8(1 Jun 1972).

The $\eta' \rightarrow \eta\pi\pi$ decay is reexamined under the assumption that the chiral- and scale-invariant limits of the action operator coincide and the dilaton exists. It is shown that an order-of-magnitude improvement over the Riazuddin–Oneda estimate for the decay rate can be obtained. Thus $\eta' \rightarrow \eta\pi\pi$ decay does not seem to pose any serious problems to the pure $(3,3^*) \oplus (3^*,3)$ breaking of chiral symmetry provided the effects of the dilaton are incorporated. (auth)

42018 REALIZATION OF SCALE AND CHIRAL SU(3) x SU(3) INVARIANCE WITH GOLDSTONE BOSONS AND BROKEN SU(3) COUPLING CONSTANTS. Eliezer, S. (Cambridge Univ., Eng.); Dutt, R. Phys. Lett.; 40B: No. 2, 250-2(26 Jun 1972).

Present experimental evidence for dilation (ϵ meson) is consistent with unsubtracted dispersion relation of $\langle P|\theta_\mu^\mu|P\rangle$ ($P = \pi, k, \eta$) dominated by two poles and SU(3) violation in ϵ PP couplings. (auth)

42019 CLASSIFICATION AND MASS FORMULAS FOR BARYONS IN THE LADDER U(6,6)-SYMMETRY. Damyanov, B. P.; Drenska, S. B.; Ivanov, M. I.; Nikolov, A. V.; Vaklev, J. S. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 25: No. 2, 159-62(1972).

The approach used for the classification of baryons differs in principle from that of previous classifications. The masses involved are in very good agreement with the experimental data. Also the masses of as yet undiscovered particles are predicted. (J.F.P.)

42020 SU(3), DUALITY, AND EXCHANGE DEGENERACY. Trilling, George H. (Univ. of California, Berkeley). pp 423-64 of Proceedings of the Fourth Hawaii Topical Conference in Particle Physics. /Yount, D. E. (ed.). Honolulu, Hawaii; Univ. of Hawaii Press (1972).

From fourth topical conference in particle physics; Honolulu, HI. (2 Aug 1971). See CONF-710819.

It is noted that hadron spectroscopy has provided the main quantitative test of SU(3) symmetry. Duality for exchange degeneracy in various π + N and K + N interactions is discussed. Elastic scattering and SU(3) relations and t-channel SU(3) relations are also treated. (J.F.P.)

Field Theories

General

42021 INTERACTION OF ELECTROMAGNETIC FIELD WITH MATTER (ANGULAR MOMENTUM BASIS). Rajput, B. S. (Kurukshetra Univ., India). Indian J. Phys.; 44: No. 11, 569-78 (Nov 1970).

Reduced expansions of electromagnetic fields are derived in terms of irreducible representations of proper, orthochronous, inhomogeneous Lorentz group in angular momentum basis. The second quantized expansions, derived by replacing photon wavefunctions and their complex conjugates by annihilation and creation operators in the reduced expansion, are given in terms of vector spherical harmonics with annihilation and creation operators as amplitudes. For calculating the interaction Hamiltonian, when the electromagnetic field is coupled to an atom, the second quantized expansion of three components transverse electromagnetic vector potential is used to avoid fictitious photons of helicity other than ± j (spin) and subsidiary state vector condition and to overcome the difficulty of vanishing amplitude for emission or absorption of photon as $p \rightarrow 0$. The selection rules, derived in the relativistically quantized manner, are identical with already known selection rules for classical radiation fields, except that the photon takes or supplies angular momentum to conserve the total angular momentum of the system. (auth)

42022 INFINITY SUPPRESSION IN GRAVITY-MODIFIED ELECTRODYNAMICS. II. Isham, C. J. (Imperial Coll. of Science and Tech., London); Salam, Abdus; Strathdee, J. Phys. Rev., D; 5: No. 10, 2548-65(15 May 1972).

It is argued that the use of a visibly localizable parametrization of the gravitational interaction yields a number of advantages. First, the question of ambiguities can be completely solved: According to a theorem of Lehmann and Pohlmeyer there exists in such theories a unique "minimally singular" solution which it is natural to adopt as the physical one. Second, it is possible to show that this solution satisfies the usual requirements of analyticity and unitarity in the sense of perturbation theory. These points are reviewed in this paper, the main object of which is to introduce a new technique for the treatment of those nonpolynomial Lagrangians in which the interaction terms are intimately associated with the free part and contain derivatives. The gravity-modified theories exemplify this type of Lagrangian: In such theories the zero-graviton approximant to any process is "cradled" in a sequence of graphs with arbitrarily large numbers of gravitons whose sum exists, is finite, and free of ambiguities. Since the problem of preserving electromagnetic (and gravitational) gauges is also the problem of derivatives occurring either in interaction Lagrangians or in the propagators, our general treatment of derivatives is expected to resolve such gauge difficulties. In particular, it is shown that both the gravity-modified photon renormalization constant and the gravity-modified electromagnetic self-mass of the electron up to order $\alpha \log G_N m^2$ (where G_N is the Newtonian constant) are gauge-invariant. (auth)

42023 SOME REMARKS ON THE KLEIN PARADOX. Dosch, H. G. (Univ., Heidelberg); Jansen, J. H. D.; Mueller, V. F. Phys. Norv.; 5: No. 3-4, 151-62(1971). (In German).

Solutions of the Dirac-equation for strong electrostatic or scalar potentials are discussed. The consistency of relativistic spinor quantum mechanics is emphasized. Whereas in the case of an electromagnetic potential Klein's paradox occurs, this phenomenon is absent in the case of a scalar potential. The behavior of the bound states in both cases and the dependence of the penetrability on the form of an electrostatic potential are investigated. (auth)

42024 NEW VARIATIONAL PRINCIPLE OF HAMILTONIAN TYPE FOR CLASSICAL FIELD THEORY. Djukic, Dj.; Vujanovic, B. (Univ. of Novi Sad, Yugoslavia). Z. Angew. Math. Mech.; 51: No. 8, 611-16(1971).

A variational principle of the Hamiltonian type for various physical phenomena is constructed. Its application to the problems of the nonlinear heat transfer and fluid flow in Eulerian description is shown. (auth)

Quantum Field Theory

Refer also to abstracts 41868, 41879, 41882, 41904, and 42054.

42025 DYNAMICS IN THE INFINITE-MOMENTUM FRAME. Hsu, J. P. (Rutgers–The State Univ., New Brunswick, N. J.); Johnson, K. D. Lett. Nuovo Cim.; 4: No. 5, 191-5(3 Jun 1972).

An investigation is made of the infinite-momentum frame and of the use of the new variables $x^+ = (t + z)/\sqrt{2}$, x^1, x^2, $x^- = (t - z)/\sqrt{2}$ in constructing a dynamics of quantized fields. The new variables are interpreted according to Dirac. As an illustration quantum electrodynamics is formulated on the basis of the front variables. (J.F.P.)

42026 WILSON EXPANSIONS, THE INTERACTION PICTURE AND COMMUTATORS IN THE WARD IDENTITY FOR THE AXIAL CURRENT. Konetschny, W.; Schweda, M. (Technische Hochschule, Vienna). Nucl. Phys.; B42: 125-40(1 Jun 1972).

The precise interpretation of Ward identities (and their anomalies) involving a current operator not belonging to some renormalizable theory can still be considered an open problem in quantum field theory. Therefore the most simple example, the Ward identity for the axial current in meson-nucleon dynamics is reinvestigated in lowest order using finite local field operators and Wilson's short distance expansions. The boson field is treated as external. No anomaly arises in the Heisenberg picture. If the perturbation theory calculation is repeated in the interaction picture a commutator is encountered which has to be finite. Neither the canonical nor the Bjorken–Johnson–Low prescription provide a consistent (i.e. finite) value for this commutator. A possible remedy for this difficulty is proposed within the framework of the approach of finite field operators furnishing a satisfactory answer. It is concluded that the Heisenberg picture is more adequate for the investigation of Ward identities with Wilson techniques while the usual Feynman perturbation methods are probably less reliable. (auth)

42027 DUAL AMPLITUDES AND THE THIRRING MODEL. Andric, I.; Gervais, J. L. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B42: 240-52(1 Jun 1972).

As shown by Virasoro, Sakita and one of the authors (J.L.G.), dual models can be constructed from any two dimensional, conformal invariant field model. This construction is carried out here in the case of the Thirring model. (auth)

42028 CONFORMAL COVARIANT CORRELATION FUNCTIONS. Ferrara, S.; Parisi, G. (CNEN, Frascati, Italy). Nucl. Phys.; B42: 281-90(1 Jun 1972).

The general constraints of "full conformal symmetry", on n-point correlation functions are discussed. An identity for the three-point correlation function is derived from conformal symmetry, which allows one to derive an integral representation for any "irreducible" conformal graph. The connections of these results to conformally covariant "generalized Wilson operator products expansions" are pointed out. Arguments which suggest a locality property of a conformal covariant expansion for the n-point functions are discussed. (auth)

42029 RELATIVISTIC DYNAMICAL ALGEBRAS FOR TWO-PARTICLE SYSTEMS. Sudbery, A. (Univ. of York, Heslington, Eng.). Nuovo Cim.; 9B: No. 2, 299-314(11 Jun 1972).

Relative variables for the motion of two relativistic particles are constructed from the generators of the product of two Poincaré groups, and the formulation of operator equations describing forces between the particles is discussed. Nonlinear algebras like those that occur in chiral dynamics arise naturally in this context; for these algebras O'Raifeartaigh's theorem does not hold. (auth)

42030 FINITE PREDICTIONS FROM A SIMPLE NONRENORMALIZABLE FIELD THEORY. Christ, N. (Columbia Univ., New York). Phys. Rev., D; 5: No. 10, 2486-2514(15 May 1972).

A simple, nonrenormalizable quantum field theory containing a scalar field derivative-coupled to a nonconserved vector current of massive fermions is investigated. A method is presented which permits the calculation of S-matrix elements as a power series in a symmetry-violating mass difference Δm_0 instead of the usual series expansion in the coupling strength g: $\langle\alpha|S|\beta\rangle = \Sigma a_n(\Delta m_0)^n$. It is shown that the resulting scattering matrix is unitary and that for $n \leq 4$ all of the coefficients in this new expansion are explicitly finite. It is not yet known whether the proposed method yields finite coefficients for all n. Finally, it is noted that these techniques can be applied to a number of other nonrenormalizable theories. (auth)

42031 FORCE AND WORK IN THE THEORY OF RELATIVITY. Moeller, C. (Niels Bohr Institutet, Copenhagen). Phys. Norv.; 5: No. 3-4, 297-302(1971).

In the theory of relativity it is important to distinguish clearly between true mechanical forces that determine the motion of a particle, and "generalized" forces which are defined as the rate of change of the momentum of the particle. The two types of force are identical only if the proper mass of the particle is constant, and this was generally the case in Newtonian mechanics. However, due to the inertia of all kinds of energy in the theory of relativity the case of constant proper mass is now rather the exception. (auth)

42032 QUANTUM-ELECTRODYNAMICS TESTS: TESTS OF $J_\mu J_\mu$ STRUCTURE IN WEAK INTERACTIONS: HIGHER-ORDER WEAK INTERACTIONS. Bjorken, James D. (Stanford Linear Accelerator Center, Calif.). pp 189-210 of Proceedings of the Fourth Hawaii Topical Conference in Particle Physics. /Yount, D. E. (ed.). Honolulu, Hawaii; Univ. of Hawaii Press (1972).

From fourth topical conference in particle physics; Honolulu, HI. (2 Aug 1971). See CONF-710819.

In this lecture quantum electrodynamics tests using the $e^+ + e^-$ interactions are described. Proposed tests of the current–current form of the low-energy structure of weak interactions include $\overline{\nu} +$ e and ν_e + e interactions, parity violation in $\Delta S = 0$ nuclear forces, and coherent production of μ pairs by neutrinos reacting with nuclei. Higher-order weak interaction theory covers lepton–lepton scattering amplitudes with forward scattering dispersion relations, $K_2^0 \rightarrow \mu^+ + \mu^-$ decay and the mass difference of K_2^0 and K_1^0, the existence of the W boson, the process $\overline{1} + 1 \rightarrow W^+ + W^-$, and the properties of sthenons (the family of all particles that interact strongly with intermediate bosons). (J.F.P.)

Gravitation and General Relativity

42033 CORRELATION BETWEEN THE GRAVITATIONAL SIGNALS IN WEBER'S EXPERIMENT AND SOLAR AND TERRESTRIAL MAGNETIC ACTIVITY. Adamyants, R. A.; Alekseev, A. D.; Kososnitsyn, N. I. (All-Union Research Inst. for Physical-Technical and Radio Measurements, Moscow). JETP Lett. (USSR) (Engl. Transl.); 15: No. 5, 194-6(5 Mar 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 5, 277-9(5 Mar 1972).

A correlation analysis was carried out, and a significant connection between the Weber data and the solar and geomagnetic activity and cosmic ray intensity was observed. The Weber experiments are interpreted as a result of the action exerted on the detectors by oscillations of the earth's magnetic field excited by fast corpuscular streams emitted by the sun. It is noted that the possibility that the Weber detector has registered bursts of gravitational waves is not fully excluded. (J.F.P.)

42034 MORE EXACT SOLUTIONS OF f–g VACUUM EQUATIONS. Urbantke, H. K. (Univ., Vienna). Lett. Nuovo Cim.; 4: No. 5, 155-6(3 Jun 1972).

It is pointed out that it is easy from the work of Kundt (Zeits. Phys., 163: 77(1961)) to generate exact solutions of the vacuum field equations of the two-tensor theory of gravity suggested by Salam et al., (Phys. Rev. Lett., 27: 1533(1971)). An invariant characterization of the solutions is that they represent all solutions of the vacuum equations of f-g theory for which the difference of the two tensor fields is the product with itself of a null vector field: $f_{\mu\nu} - g_{\mu\nu} = l_\mu l_\nu$, where $g^{\mu\nu} l_\mu l = 0$. It is noted that one can show that the field equations require l_μ to be tangent to a geodesic null congruence with vanishing shear, twist, and expansion, which automatically leads to the fields studied by Kundt. (J.F.P.)

42035 NONLINEAR ANALYSIS OF GRAVITATIONAL INSTABILITY. Petit, J. P. (Univ., Aix-Marseille). Compt. Rend., Ser. B; 274: No. 8, 574-6(21 Feb 1972). (In French).

A nonlinear analysis of gravitational instability is presented, in which the velocity distribution is assumed to have a localized Maxwellian form. Concepts of the kinetic theory of gases, and the Chapman and Cowling formalism, are used. (France)

42036 SPACE-TIME DEDUCED FROM A MINKOWSKI METRIC BY INTRODUCTION OF AN ASYMMETRIC NONSTATIC DEVIATION. Vincensini, P. Dominique. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 50: No. 6, 721-4(Jun 1972). (In French).

A new geometric interpretation of the deviation function of the Minkowski space metric is found. In such a space the congruence tangent to the real isotropic vectors directed toward the future is always geodesic and without rotation. The parameter of displacement along this congruence is an affine parameter. Also the deviation function of the metric of the space is the ratio between the complex distorsion and the complex rotation of the congruence. (J.F.P.)

42037 FURTHER EVIDENCE FOR AN ANOMALOUS INTERACTION BETWEEN THE ELECTROMAGNETIC AND GRAVITATIONAL FIELDS. Woodward, J. F.; Yourgrau, W. (Univ. of Denver). Nuovo Cim.; 9B: No. 2, 440-52(11 Jun 1972).

Due to the fact that the interplanetary time delay and radio-frequency quasar deflection results appear to be at variance with the hypothesis of the frequency dependence of the speed of light in a gravitational field, the data from the optical-frequency deflection experiments are re-analysed to see if the gravitational-electromagnetic field interaction is a function of the electromagnetic and gravitational field intensities. This analysis and a statistical investigation designed to test the physical significance of the results of the analysis indicate that it is probable that the field intensities, as well as the frequency of the electromagnetic field, are parameters of the interaction. It is noted that Duchesne and

Vigier's recent work which suggests that the photon has a finite rest mass supports the frequency-dependence hypothesis. (auth)

42038 INCONSISTENCY OF FINITE RANGE GRAVITATION. Boulware, D. G. (Univ. of Washington, Seattle); Deser, S. Phys. Lett.; 40B: No. 2, 227-9(26 Jun 1972).

Gravitational theories with arbitrarily large but finite range either violate basic physical requirements, do not limit to general relativity, or both. (auth)

42039 GRAVITATIONAL RADIATION EXPERIMENTS. Aplin, Peter S. (Univ. of Bristol, Eng.) Contemp. Phys.; 13: No. 3, 283-93(May 1972).

A review is presented of the experimental work on gravitational radiation, from its prediction by Einstein as a part of the general theory of relativity. After a long program of development of detectors, J. Weber claimed to have detected intense bursts of gravitational radiation emanating from unknown sources beyond the solar system. At present there is no evidence from independent sources to confirm Weber's results, but his work has stimulated widespread activity among experimental and theoretical workers. Should Weber's results be confirmed, the prospect of a new form of astronomy opens up. (auth)

42040 GRAVITATIONAL RADIATION: THE THEORETICAL ASPECT. Hawking, S. W. (Cambridge Univ., Eng.). Contemp. Phys.; 13: No. 3, 273-82(May 1972).

The theory of relativity requires that there should be a gravitational analog to electromagnetic radiation. It is impossible to generate relevant measurable quantities in the laboratory, but recent observations indicate that there may be a very large flux coming from the center of the galaxy. Collisions between gravitationally collapsed objects (black holes) seem to be the only mechanism which could produce this amount of radiation. (auth)

42041 CONCERNING THE EXPERIMENTUM CRUCIS FOR THE PROOF OF THE SPACE-TIME ABSOLUTENESS. Marinov, S. (Inst. of Physics, Sofia). Phys. Lett.; 40A: No. 1, 73-4 (19 Jun 1972).

It is shown that the experiment proposed previously for the measurement of the transverse light Doppler effect can not be considered as an experimentum crucis between special relativity and absolute space-time theory in which the Lorentz transformation takes its legitimate place. A modification of the socalled "rotor" experiment is proposed which can serve as an experimentum crucis between both theories. (auth)

42042 MERCURY'S PERIHELION ADVANCE: DETERMINATION BY RADAR. Shapiro, Irwin I. (Massachusetts Inst. of Tech., Cambridge); Pettengill, Gordon H.; Ash, Michael E.; (and others). Phys. Rev. Lett.; 28: No. 24, 1594-7(12 Jun 1972).

Measurements of echo delays of radar signals transmitted from earth to Mercury have yielded an accurate value for the advance of the latter's perihelion position. Given that the sun's gravitational quadrupole moment is negligible, the result in terms of the Eddington-Robertson parameters is $(2 + 2\gamma - \beta)/3 \simeq 1.005 \pm 0.007$, where $\gamma = \beta = 1$ in general relativity, and where 0.007 represents the statistical standard error. Inclusion of the probable contribution of systematic errors raises the uncertainty to about 0.02. (auth)

42043 INTERMEDIATE-RANGE GRAVITY: A GENERALLY COVARIANT MODEL. O'Hanlon, John (Univ. of New Brunswick, Fredericton). Phys. Rev. Lett.; 29: No. 2, 137-8(10 Jul 1972).

A generally covariant classical model for gravity, which in the limit of weak fields is essentially equivalent to Fujii's massive dilation theory, is obtained when the invariance under a group of space-time-dependent geometry-preserving mass-unit transformations of a scalar-tensor theory is broken by ascribing a mass to the scalar field. The experimental consequences are discussed. (auth)

42044 HAMILTONIAN FORMULATION OF SPHERICALLY SYMMETRIC GRAVITATIONAL FIELDS. Berger, B. K.; Chitre, D. M.; Moncrief, V. E.; Nutku, Y. (Univ. of Maryland, College Park). Phys. Rev., D; 5: No. 10, 2467-70(15 May 1972).

Hamiltonian methods are used to study spherically symmetric gravitational fields with electromagnetism and a massless scalar field as sources. The constraints reduce to a first-order linear ordinary differential equation which is solved to yield the dynamical Hamiltonian, or the complete solution when no dynamics is present in the problem. (auth)

42045 GRAVITATIONAL RADIATION FROM RELATIVISTIC SYSTEMS. Peters, P. C. (Univ. of Washington, Seattle). Phys. Rev., D; 5: No. 10, 2476-85(15 May 1972).

Gravitational radiation is calculated for two selected systems, a pair of masses interacting through scalar or vector fields, to illustrate the behavior of gravitational radiation when the emitting bodies have arbitrarily large velocities. Explicit expressions are obtained for the radiation potentials and radiated power, which can be used for any orbit or trajectory. Although the radiation exhibits the same relativistic peaking as is found in electromagnetism, the amount of energy radiated is found to depend critically on the kind of stresses binding the system. Numerical calculations are done for the cases of circular orbits and extreme hyperbolic trajectories, in order to show the transition from the nonrelativistic limits. The extreme hyperbolic case also allows comparison with previous results obtained for the gravitational deflection of a small mass in an unbound trajectory. (auth)

42046 RELATIVISTIC DISKS. I. BACKGROUND MODELS. Voorhees, Burton H. (Univ. of Texas, Austin). Phys. Rev., D; 5: No. 10, 2413-18(15 May 1972).

Relativistic kinetic theory is used in conjunction with the theory of relativistic surface layers in order to study relativistic disks of matter. After a brief general discussion, attention is restricted to the case of counter-rotating disks. The general surface stress-energy tensors of such disks are exhibited and a distribution function which generates these stress-energy tensors is deduced. This is followed by a discussion of stability, and a criteria for the stability of particle orbits is derived. Finally, the question of central red shift is considered. It is shown that all counter-rotating disks without singularities at the rim will have a finite central red shift, but the question of the existence of a maximum central red shift remains open. (auth)

42047 EMISSION OF RELATIVISTIC CHARGE MOVING RECTILINEARLY IN THE GRAVITATION WAVE FIELD. Dimanshtein, F. A. (Kharkov State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 11, 1877-87(Nov 1971). (In Russian).

A change in the relativistic charge emission is considered under conditions of the charge-gravitation wave interaction due to the wave spatial anisotropy for the purpose of the gravitation wave detection. (auth)

42048 EQUIVALENCE PRINCIPLE AND THE DIRAC EQUATION WITH GRAVITATION. Klein, O. Phys. Norv.; 5: No. 3-4, 145-7(1971).

Using a procedure close to that used by Bargmann in his study of the Dirac equation in general relativity it is shown how, in accordance with the equivalence principle, the gravitational field can be removed at any nonsingular space-time point by a local transformation consisting of a coordinate transformation, which removes the i/kl of the Einstein theory, combined with an S-transformation of the matrices. (auth)

42049 REMARK ON THE SUPERPOSITION PRINCIPLE FOR GRAVITATIONAL WAVES. Aichelburg, P. C. (Univ., Vienna). Acta Phys. Austr.; 34: No. 3, 279-84(1971).

The metric for various types of nonvacuum plane fronted gravitational waves is obtained from δ-like sources by linear superposition. Pure, scalar-, and electromagnetic-gravitational pp-waves are discussed. (auth)

42050 TEST OF GENERAL THEORY OF RELATIVITY. Strnad, J. Obz. Mat. Fiz.; 18: No. 4, 162-8(Dec 1971). (In Slovene).

A summary is presented of tests of general relativity (reported in English-language journals). The tests reported were made by various methods, for example, radio interferometry, radar observations of signals reflected from planets, the Argonne-Maryland disc-cylinder experiment, and anisotropy in gravitational radiation detector intensity as a function of sidereal time. 13 references. (TTT)

Scattering Theory

Refer also to abstracts 41886, 42027, 42028, and 42228.

42051 (COO-3001-10) PHYSICAL APPLICATIONS OF ANALYTIC APPROXIMATION THEORY. Lectures. Chao, Y. A. ([State Univ. of New York, Stony Brook. Dept. of Physics]). [1972]. Contract AT(11-1)-3001. 17p. Dep. NTIS.

Analytic approximation theory is discussed for the extraction of scattering amplitudes from scattering data. The convergence properties of polynomial interpolation and the optimized mapping and probabilistic measures of the convergence rates of interpolating series are considered. (J.F.P.)

42052 (IFA-FT-91) WEIGHTED DISPERSION RELATIONS AND CUT TO CUT EXTRAPOLATIONS. Ciulli, S.; Nenciu, G.

(Institutul de Fizica Atomica, Bucharest (Romania). Nordisk Institut for Teoretisk Atomfysik, Copenhagen (Denmark)). 1971. 14p. Dep. NTIS (U. S. Sales Only).

Using error-affected data for the scattering amplitude on a part of the cuts, a stable extrapolation procedure for it to the remaining parts of the cuts (higher energies or crossed reactions) is constructed using Carleman-weighted dispersion relations. To this end, it is assumed that the amplitude satisfies on the cut some smoothness condition of the Hoelder type. (auth)

42053 (JINR-E2-6400) SL(2,R) SYMMETRY OF THE DUAL TWO-PARTICLE AMPLITUDE. Popov, C. D.; Stoyanov, D. Ts.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 55p. Dep. NTIS (U. S. Sales Only).

On the basis of the dispersion relations a Mellin-type integral representation for the crossing-symmetrical two-particle scattering amplitude is obtained. It is shown, that duality is a consequence of some symmetry of the amplitude with respect to the irreducible unitary representations of the group SL(2,R). This symmetry allows one to write down an integral representation for the amplitude, which could be useful for combining duality and unitarity of the amplitude. (auth)

42054 MANDELSTAM REPRESENTATION FOR THE BETHE-SALPETER AMPLITUDES. Cheung, F. F. K. (Univ. of Notre Dame, Ind.). Contract AT(11-1)-427. Int. J. Theor. Phys.; 5: No. 4, 213-19(1972).

Mandelstam representation is shown to be valid for the total Bethe–Salpeter scattering amplitude in the ladder approximation. (auth)

42055 s-CHANNEL HELICITY CONSERVATION IN ELASTIC PROCESSES. Langacker, Paul (Univ. of California, Berkeley). Phys. Rev., D; 5: No. 11, 2864-8(1 Jun 1972).

The unitarity equation for elastic partial-wave amplitudes is considered. Defining helicity-total-flip elastic amplitudes as those in which both helicities change sign, it is observed that the unitarity equation strongly suggests that the imaginary part of the helicity-total-flip partial-wave amplitude is much smaller than that of the nonflip amplitude at high energies. Appealing to a plausibility argument, the ratio of helicity-total-flip to helicity-nonflip partial-wave amplitudes is estimated to be $(1/s)^{1/4}$ or smaller. The implications of this result for the full amplitude, the possibility of extending the result to other amplitudes if factorization is true, and the implications for Regge theory are discussed. (auth)

42056 APPLICATION TO THE SCATTERING PROBLEM OF A HIGHER-ORDER MODIFIED WKB APPROXIMATION DUE TO MILLER AND GOOD. Lu, P.; Measure, E. M. (Arizona State Univ., Tempe). Phys. Rev., D; 5: No. 10, 2514-18(15 May 1972).

The modified WKB method due to Miller and Good is used to derive the scattering phase-shift formula including $\hbar^4$ terms for the radial equation of the three-dimensional scattering problem. (auth)

42057 OPTIMIZED DATA EXTRAPOLATION OFF THE BOUNDARY OF AN ANALYTIC FUNCTION. Shepard, H. K. (Univ. of New Hampshire, Durham); Shih, C. C. Nucl. Phys.; B42: 397-417(1 Jun 1972).

The problem of extrapolation of a function whose real and imaginary parts are not equally well known on the boundary of its analytic domain. Using an integral equation for the error correlation function, the optimized extrapolated value of the function and the probable error in extrapolation are examined. For several cases, specific solutions are obtained which illustrate general properties and are also useful in phenomenological applications. Comparing with ordinary dispersion relations, it is noted when the extrapolation error may be uncontrolled, or only weakly constrained, by the input data, and how a knowledge of other properties of the function, e.g. its threshold or high energy behavior may be necessary in order to reduce the extrapolation error. (auth)

42058 VARIATIONAL PRINCIPLES AND PADE APPROXIMANTS. RESONANCES AND PHASE SHIFTS IN POTENTIAL SCATTERING. Alabiso, C.; Butera, P.; Prosperi, G. M. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). Nucl. Phys.; B42: 493-517(1 Jun 1972).

In the context of Padé approximation theory some methods are studied for the calculation of the resonances and the phase shifts in potential scattering. They are extensions of a method already used for the determination of the bound states and are based on the variational content of the Padé approximation. Essentially these methods amount to work with off-shell amplitudes taking the off-shell momenta as variational parameters. Numerical examples are reported which always show a definite improvement over the results of the conventional on-shell Padé approximation. (auth)

PHYSICS (LOW-TEMPERATURE)

42059 PHASE TRANSITIONS AND CRITICAL PHENOMENA IN QUANTUM SYSTEMS. Boccara, N. (CEN de Saclay, Gif-sur-Yvette, France). Ber. Bunsenges. Phys. Chem.; 76: No. 3-4, 193-6(Apr 1972).

From the point of view of phase transitions and critical phenomena, quantum systems do not differ from classical systems. Such concepts as order parameters, self-consistent approximations, and critical exponents are reviewed for both types of systems and their similarities are stressed with the help of group theoretical considerations. (auth)

42060 SUPERCONDUCTING LEVITRON (4 Jun 1969) (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-2203).

2 drawings.

The Superconducting Levitron, used in testing schemes of plasma confinement, contains an 80 cm dia superconducting ring as well as three pairs of superconducting coils that produce a poloidal field. The coils, which are 50, 112, and 160 cm in dia, are located 40 cm above and below the midplane of the ring. Twelve control coils and optical position sensors form a feedback system for maintaining the ring's position. Two magnetic damping plates are located 14 cm above and below the ring, just outside of the plasma region to prevent the ring from making accidental but dangerously violent movements. The assembly of damping plates, ring and coils, structural supports, and liquid-He-piping system is supported from the main vacuum tank cover and is surrounded by a radiation heat shield, which is cooled by liquid N. A 100 liter-bottom-outlet He dewar, located above the cover, provides a He reservoir. The 14 current leads for the coils enter the top of the dewar through a 4 in. neck. The coil assembly and the dewar can be lifted out of the vacuum tank as one integrated unit, allowing complete access to the system. A toroidal winding encloses the entire assembly. (For details see TID-4100, Suppl. 70) (see also NSA 25: 43399) (F.S.)

Superfluidity

42061 STUDY OF ^{3}He AND ^{3}He–^{4}He MIXTURES NEAR THE LIQUID–VAPOR CRITICAL POINT. Wallace, Barnie Alvin Jr. Durham, N. C.; Duke Univ. (1971). 161p. University Microfilms Order No. 72-8500.

Thesis.

Extensive PVT measurements were made for both pure ^{3}He and ^{3}He–^{4}He mixtures near the liquid–gas critical point. Volume changes of 1 part in 10^6, pressure changes of 2 parts in 10^5, and temperature changes of 1 part in 10^6 could be detected. Considerable care was taken in the design of the apparatus to insure that true equilibrium was quickly obtained and that the large compressibilities near the critical point did not result in significant molar volume errors due to the gravitational field. Values for most of the critical indices of ^{3}He are presented and compared with the scaling ideas and with the results of other workers. The pressure versus density measurements were graphically integrated along the isotherms for pure ^{3}He to obtain the chemical potential change $\{\Delta\mu = [\mu(\rho,T) - \mu(\rho_c,T)]/P_cV_c\}$ as a function of density change $[\Delta\rho = (\rho - \rho_c)/\rho_c]$. Density measurements along the critical isotherm of ^{3}He outside of the range where the scaling ideas are valid are presented, and it is shown that here a symmetric density term must be added to the antisymmetric term for an adequate description. Isotherm data for six ^{3}He–^{4}He mixtures are presented, and it is shown that, collectively, the boiling and dew curves at constant concentration are similar in shape to the coexistence curve of a pure fluid. These results are used to find the critical line for ^{3}He–^{4}He mixtures, and graphs are presented from which the T_c, P_c, and V_c values can be found at any concentration. By interpolating the boiling and dew curves true coexistence curves of ρ versus P at constant T values and ρ versus T at constant P values were determined. Values of the critical index β were then found to be slightly, but not significantly, higher than the β for pure ^{3}He. Special emphasis was placed on finding how the compressibility, k_T, changed as the critical point was approached. Comparisons with various modern theories of critical behavior in multicomponent systems are presented. Boiling and dew curves at 2, 2.5, and 3°K were constructed from measurements at the various concentrations and were found to be thermodynamically consistent. Also, a discussion is presented of the boiling and dew curves of Eselson and Berezniak (1956), who first published both such measurements, and it is concluded, in agreement with other authors, that these data are thermodynamically inconsistent. The excess Gibbs free energy, which measures the deviation of the boiling and dew curves for a given isotherm from ideal solution theory, is evaluated and given graphically, along with a comparison of previous results. (TSS) (Diss. Abstr. Int., B)

42062 OBSERVATIONS ON SINGLE VORTEX LINES IN ROTATING SUPERFLUID HELIUM. Packard, Richard E.; Sanders, T. M. Jr. (Univ. of Michigan, Ann Arbor). Phys. Rev., A; 6: No. 2, 799-807(Aug 1972).

The appearance of individual quantized vortex lines in liquid He II was detected in narrow-diameter (~1 mm) rotating cylindrical vessels which were slowly accelerated from rest. The angular velocities where the lines appear are qualitatively consistent with theory based upon minimization of the free energy. However, one finds that the detailed behavior of the He II is quite history dependent and cannot be uniquely determined from existing theory. The detection technique involves charging the vortex lines for a fixed length of time. A subsequent measurement of the amount of charge trapped provides an indication of the number of vortex lines present. In order to detect the small amount of charge trapped on a single line, the trapped electrons were extracted through the meniscus and a proportional counter was developed to detect them in the vapor. (auth)

42063 SUPERMOBILITY AND ZERO SOUND IN DILUTE ^{3}He–^{4}He MIXTURES UNDER PRESSURE. Hoffberg, Mark B. (Vassar Coll., Poughkeepsie, N. Y.). Phys. Rev., A; 5: No. 4, 1693-6 (Apr 1972).

Experimental measurements of the osmotic pressure in liquid ^{3}He–^{4}He mixtures made by Landau et al. suggest the possibility of a higher supermobile transition temperature than previously estimated, the possibility of p-state pair formation in the supermobile condensate, and the possibility of the existence of zero sound, for mixtures under sufficiently high external pressure. (auth)

42064 KAPITZA RESISTANCE BETWEEN COPPER AND ^{3}He. Anderson, A. C.; Johnson, W. L. (Univ. of Illinois, Urbana). J. Low Temp. Phys.; 7: No. 1-2, 1-21(Apr 1972).

The Kapitza resistance R_K between copper and ^{3}He was measured at low pressure in a guarded cell in the temperature range 0.05 to 0.5°K. An extreme sensitivity to surface damage was observed. For an annealed, electropolished surface R_K agreed within a factor of two with the acoustic mismatch theory below ≈ 0.1 K. It was also noted that R_K between copper and liquid ^{3}He was identical to R_K between copper and an adsorbed ^{3}He film. The data are compared with several mechanisms proposed theoretically to account for R_K. (auth)

42065 PHONON INTERACTION IN A QUANTUM LIQUID (^{4}He). Zagrebnov, V. A. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 5, 568-78(Sep-Oct 1971). (In Russian).

A system of interacting phonons (quanta of acoustic excitations) in a liquid was examined in the form of a Hamiltonian. Its reduction to a normal form made it possible to allow for contributions from anharmonic members of a given series in the free portion of the Hamiltonian and in the interaction. Based on the normalized Hamiltonian, the dispersion of phonons in liquid ^{4}He was considered. (tr-auth)

42066 IONS AND RING VORTEXES IN SUPERFLUID HELIUM. Slyusarev, V. A.; Strzhemechnyi, M. A. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1927-32(May 1972). (In Russian).

Two possible models of formation of an ion–vortex ring observed in experiments with charged particles in superfluid helium are considered. It is shown that an axisymmetric location of the ion with respect to the ring is unstable for large rings. A model Lagrangian is proposed for a model in which the ion is assumed to be fixed to the vortex filament. (auth)

42067 MEASUREMENT OF THE HEAT OF TRANSITION OF ^{3}He FROM ONE LIQUID PHASE OF THE ^{3}He–^{4}He SOLUTION TO ANOTHER. Gladun, A.; Peshkov, V. P. (Inst. of Physical Problems, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1853-7 (May 1972). (In Russian).

The heat of transition of ^{3}He from a solution phase enriched in ^{3}He to a phase enriched in ^{4}He was measured. The measurements were performed between 0.02 and 0.70°K. Below 0.05°K the heat of transition is (80 ± 3) T^2 [J/mole °K^2]; it is maximal at 0.54°K and equal to 4.5 J/mole. The heat of transition data is in good agreement with available data on the specific heats of ^{3}He, ^{4}He and solutions of ^{3}He in ^{4}He and also with the shape of the solution stratification curve. (auth)

42068 ROTON VISCOSITY AND ROTON–ROTON INTERACTIONS IN SUPERFLUID HELIUM. Nagai, Katsuhiko (Tokyo

Univ.); Nojima, Koichiro; Hatano, Akira. Progr. Theor. Phys. (Kyoto); 47: No. 2, 355-69(Feb 1972).

Assuming a δ-function type interaction between rotons as was done by Landau and Khalatnikov, the roton–roton scattering is treated exactly, taking into account the scattering processes to infinite order. The roton viscosity coefficient η_r is calculated with use of the exactly calculated roton–roton scattering cross section. The calculated roton viscosity shows a behavior different from that which Landau and Khalatnikov predicted by means of the Born approximation, that is: (1) η_r is temperature-dependent; (2) η_r has a lower bound three times as large as the experimental value of the roton viscosity. Therefore, the calculated η_r cannot be matched with experiment for any value of the coupling constant. It is emphasized that the angular dependence of the roton–roton interaction should be taken into account to obtain agreement with experiment. (auth)

42069 FORCES IN THE FLOW OF LIQUID HELIUM II. I. FLOW WITH SMALL SUPERFLUID VELOCITY. Van der Heijden, G.; de Voogt, W. J. P.; Kramers, H. C. (State Univ., Leiden). Physica; 59: No. 3, 473-97(1 Jun 1972).

The simultaneous flow of the superfluid and normal components of liquid He-II through a capillary is studied. The manner in which the two fluids are forced to flow with independently adjustable velocities is described. The temperature and chemical-potential drop over the capillary are measured, from which the pressure drop can be derived. In subcritical as well as in supercritical flow with small v_s, the pressure drop equals the Poiseuille pressure drop of the normal fluid, indicating that the normal fluid is not turbulent, but flows laminarly. No pressure drop of the superfluid has been present. The results on the pressure drop are contrary to the results of other experiments, in which an additional pressure drop has been observed. (auth)

42070 GALILEI INVARIANCE AND SUPERFLUIDITY. Sen, R. N.; Zahavi, D. (Technion-Israel Inst. of Tech., Haifa). Physica; 59: No. 3, 379-84(1 Jun 1972).

It is pointed out that true zero-mass reducible representations of the Galilei group have the same Galilei transformation properties as Landau excitations in superfluid helium. (auth)

42071 SURFACE TENSION OF HELIUM II FILMS. Chan, S. L. (Univ. of Malaya, Kuala Lumpur). Can. J. Phys.; 50: No. 11, 1139-42(1 Jun 1972).

The contribution from surface wave modes to the temperature behavior of the surface tension of both saturated and unsaturated helium II films is considered. It is found that in saturated films the surface tension has a T^2 dependence and this comes solely from capillary wave modes. The result holds in the approximate temperature range 10^{-6} °K < T < 0.8°K. For T ≫ 0.8°K and for very thick saturated films, Atkins' expression for the surface tension of bulk helium II is obtained. In thin unsaturated films the surface tension varies as T^2 at relatively high temperatures when capillary modes still dominate the surface excitations and when the normal component is totally locked to the substrate. Below a certain temperature, which depends on the film thickness, third sound waves become predominant and the surface tension varies as T^3. (auth) (Canada)

Superconductivity

Refer also to abstract 40986.

42072 (BNL–16747) FACTORS INFLUENCING THE CHOICE OF SUPERCONDUCTOR IN AC POWER TRANSMISSION APPLICATIONS. Forsyth, E. B.; Garber, M.; Jensen, J. E.; Morgan, G. H.; Britton, R. B.; Powell, J. R.; Blewett, J. P.; Gurinsky, D. H.; Hendrie, J. M. (Brookhaven National Lab., Upton, N. Y.). 1972. 10p. (CONF-720513–1). Dep. NTIS.

From Applied superconductivity meeting; Annapolis, MD. (1 May 1972).

It has been shown that the choice of superconducting material must be made to optimize the performance and cost of the complete system. Probably the most important properties required are as high an operating temperature as possible and a temperature differential along the line of at least two degrees. By operating above 6°K, the refrigeration costs are minimized and the cooling system becomes much more efficient. This requirement stems from the surprising result of computer runs to determine refrigeration characteristics for identical cables operating above and below 6°K. Niobium lines required about twice as much input power to the refrigerators as niobium–tin lines despite the inherently lower loss factor of niobium. Electrical network requirements can be satisfied with a maximum linear current density of about 500 A/cm. It is fortuitous that this value is precisely in the range at which acceptable losses are obtained and also provides transmission power densities competitive with other transmission technologies. The requirement that an underground cable shall be capable of immediately resuming transmission after a fault dictates the use of a type-II material of sufficient thickness to prevent reversion to the normal state under any foreseeable conditions. The losses of presently available niobium–tin are marginally acceptable and some reduction is desirable. If this can be achieved by means of layered conductor construction, metallurgical treatment or other means then niobium–tin will be superior to any other material for construction of 60 Hz power transmission cables. (auth)

42073 (LA-DC–72-470) SUPERCONDUCTING MAGNETIC ENERGY STORAGE AND TRANSFER. Laquer, H. L.; Lindsay, J. D. G.; Little, E. M.; Weldon, D. M. (Los Alamos Scientific Lab., N. Mex.). [1972]. 7p. (CONF-720513–2). Dep. NTIS.

From Applied superconductivity meeting; Annapolis, MD. (1 May 1972).

Model experiments have shown that energy transfer at millisecond times from a superconducting storage coil into resistive loads can be achieved with a normal-going superconducting switch. It is planned to extend these studies to 300-kJ and 6-MJ systems, as well as to transformer-coupled inductive loads. (auth)

42074 EFFECT OF IMPURITY GAS ADDITIONS ON THE SUPERCONDUCTING CRITICAL CURRENT OF VAPOR-DEPOSITED Nb_3Sn. Enstrom, R. E.; Hanak, J. J.; Appert, J. R.; Strater, K. (RCA Labs., Princeton, N. J.). J. Electrochem. Soc.; 119: No. 6, 743-7(Jun 1972).

The addition of various gaseous impurities into the process gases used in the chemical vapor deposition of superconducting Nb_3Sn was found to alter the grain size of Nb_3Sn and thereby the critical current (I_c). Increasing concentrations of CO_2, CO, and N_2 cause a progressive decrease in the particle size and a concomitant increase of I_c up to three times the value found for undoped specimens. In contrast, O_2 and CH_4 increase the particle size and reduce I_c. I_c is linearly dependent on the reciprocal of the grain size, 1/D, to values of D as small as 400 Å. The present work suggests that impurities serve to control the grain size, presumably by the formation of small second-phase precipitates which interfere with the growth of Nb_3Sn grains. (auth)

42075 PRINCIPLES AND METHODS OF LOW-FREQUENCY ELECTRIC AND MAGNETIC MEASUREMENTS USING AN rf-BIASED POINT-CONTACT SUPERCONDUCTING DEVICE. Giffard, R. P.; Webb, R. A.; Wheatley, J. C. (Univ. of California, San Diego, La Jolla). Contract AT(04-3)-34, P. A. 143. J. Low Temp. Phys.; 6: No. 5-6, 533-610(Mar 1972).

A comprehensive study was made of some low-frequency electric and magnetic measurements that can be made using an rf-biased point-contact superconducting device of the symmetric two-hole type introduced by Zimmerman. The phenomena observed and utilized in making the measurements are described qualitatively. A semiquantitative and semi-empirical analysis is made of the weakly superconducting system as it interacts with the rf field. Reasonable agreement between the analysis and experiment is obtained, thereby establishing a basis for optimization of conditions for measurement. Empirical data are also given as needed on coupling-coil characteristics. Noise in the measuring system is discussed and the characteristics of the flux-locked loop used in the measurements introduced. It is shown that the total observed noise may be divided into at least three parts: one intrinsic to the sensor, one which reflects voltage noise in the amplifier, and one coupled into the instrument by the measuring circuit. The noise power spectra of the first two are shown to be comparable in an actual system. Below 100 Hz, the spectrum relative to the square of the flux quantum, is white and estimated by 10^{-8} Hz^{-1}. The characteristics are discussed of a dc voltmeter using a flux-locked loop and having a relatively high input impedance and a good noise figure. An experimental study of noise is presented. A particular case with subpicovolt sensitivity limited by Johnson noise is discussed. Low-frequency ac measurements of resistance, self-inductance, and mutual inductance are discussed using a novel bridge circuit and the superconducting sensor in a flux-locked loop as null detector. The noise characteristics are described and studied experimentally. Extreme sensitivity is achieved, both in resistance and inductance. A 1-$\mu\Omega$ resistor may be measured with a precision of 1 part in 10^5 with subpicowatt power dissipation. Measurements of the mutual inductance due to a 1.6-mg crystal of CMN are described in which the crystal temperature was reduced to the millidegree region. Measurements of static magnetization are discussed and the ideas applied to measurement of temperature using milligram quantities of CMN. Measurements using a pair of thermometers, one inside and the other outside the mixing chamber of a dilution refrigerator, are presented. The concept of a device-noise temperature is introduced and shown to be in the microdegree region. A very simple Johnson noise thermometer is then described. Measurements with this thermometer in the mixing chamber of a dilution refrigerator were carried out to 12 mK, the effective device temperature being measured to be +0.8 ± 1.3 mK. A qualitative experimental estimate places the actual device temperature well below 1 mdeg. Appendices include a technical discussion of the flux-locked loop and of noise. (auth)

42076 CURRENT–VOLTAGE CHARACTERISTICS OF Pb DAYEM BRIDGES. Chen, J. T.; Kim, S. H.; Kim, Y. W. (Wayne State Univ., Detroit). J. Appl. Phys.; 43: No. 3, 1218-21(Mar 1972).

The negative-resistance region was investigated in the current–voltage characteristics of Pb Dayem bridges (superconducting weak links). The conditions for observing the negative-resistance region agree with the recent theoretical predictions of Warman and Blackburn who have taken into account the effect of bias-source resistance on the current–voltage characteristics. (auth)

42077 SUPERCONDUCTIVITY OF MERCURY IN CHRYSOTILE ASBESTOSES. Bogomolov, V. N.; Krivosheev, V. K.; Kumzerov, Yu. A. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 12, 3148-50(Jun 1972).

Translated from Fiz. Tverd. Tela; 13: No. 12, 3720-2(Dec 1971).

A study was made of the superconducting transitions of mercury filaments in a matrix of chrysotile asbestoses by the contact method. The transition has a wide temperature spread, and a size effect is operative. Samples of mercury in porous glasses under hydrostatic pressure were also studied for comparison. There is a series of sharp steps in the transition curves for the asbestoses. From the critical current curves, the currents flow through the whole cross section of the samples. (D.L.C)

42078 STRUCTURAL INSTABILITY, ANHARMONICITY, AND HIGH-TEMPERATURE SUPERCONDUCTIVITY IN A-15-STRUCTURE COMPOUNDS. Testardi, L. R. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., B; 5: No. 11, 4342-9(1 Jun 1972).

The strain dependence of T_c, inferred from velocity of sound data, is given for a number of A-15-structure compounds. Arguments relating the high T_c and the structural instability are presented and a correlation of the corresponding strain dependences is proposed. The unusual anharmonicity expected is confirmed by old and new experimental data. A model for the superconducting and anomalous-normal-state properties, based on the anharmonicity rather than singular bare-electron properties, is presented. Several conjectures on structural instability and high-temperature superconductivity are made. (auth)

42079 ac RESPONSE AND LOSSES OF DIFFERENTLY PINNED TYPE-II SUPERCONDUCTORS. Furtado, C. S. (Clarendon Lab., Oxford). J. Low Temp. Phys.; 7: No. 1-2, 23–42 (Apr 1972).

Measurements of the penetration of flux and losses in ac fields (20–2000 cps) at 4.2 K together with quasistatic magnetization curves on three samples of $Ta_{92}Nb_8$ having different degrees of pinning are presented. The results are explained in terms of surface shielding currents taking into account both the pinning strength and the flux-flow resistivity exhibited by the bulk. A quantitative approach is used in which the concept of flux-flow resistivity proves applicable when the sample is subjected to an ac magnetic field. (auth)

42080 TUNNELING PHENOMENA IN SUPERCONDUCTORS. Rauluszkiewicz, Jerzy (Inst. of Physics, Warsaw). Postepy Fiz.; 23: No. 2, 181-200(1972). (In Polish).

An introductory review of tunneling phenomena in superconducting junctions is given. The one-electron and Josephson tunneling are discussed. Some applications of superconducting tunneling junctions are mentioned. (auth)

42081 CURRENT INDUCED INTERMEDIATE STATE IN THIN FILM SUPERCONDUCTORS. Huebener, R. P.; Kampwirth, R. T. (Argonne National Lab., Ill.). Solid State Commun.; 10: No. 12, 1289-93(15 Jun 1972).

High-resolution magneto-optical studies of the current-induced intermediate state in superconducting lead films indicate a magnetic structure consisting of chains of flux tubes rapidly moving along channels from both edges to the center of the strip. At increasing levels of the transport current new flux tube channels are created abruptly, resulting in relatively large resistive voltage steps. (auth)

42082 SUPERCONDUCTING BRIDGES MADE OF FILMS SUPERIMPOSED WITH FERROMAGNETIC METALS. Taguchi, Isao; Yoshioka, Hide (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 33: No. 1, 92-9(Jul 1972).

Superconducting bridges were constructed using tin films superimposed with ferromagnetic nickel. The critical currents were strongly depressed in the gapless state compared with the mean-field critical currents given by Ginzburg–Landau equations. In the presence of an applied microwave field, (1) quasiperiodic power dependence of induced current steps was observed, (2) no subharmonic step appeared, (3) the step structure resembled that of point contacts. These observations in the superconducting bridges are different from those in Anderson–Dayem bridges reported earlier. It was concluded that these bridges in the gapless state are very weak links and have a sinusoidal current-phase relationship. (auth)

42083 BOSON METHOD IN SUPERCONDUCTIVITY: APPLICATION TO THE STUDY OF THE JOSEPHSON EFFECT. Leplae, L; Mancini, F.; Umezawa, H. (Univ. of Wisconsin, Milwaukee). Nuovo Cim.; 9B: No. 2, 233-58(11 Jun 1972).

The boson method in superconductivity is applied to the study of the Josephson effect. This approach permits the calculation of all the important observable quantities, like the magnetic field and the current, at any point of the system, without making use of any phenomenological assumption, such as $J = j_1 \sin \varphi$. The results of the calculation show a qualitative agreement with those computed by other authors on the basis of the Josephson equation, though this equation is not used. The boson method is also able to yield results for a neutral superconductor, so that the calculations can be applied to the analogous effects that can be found in superfluid liquids. Finally, it is pointed out that the results do not necessarily satisfy the phenomenological equation $J = j_1 \sin \varphi$. (auth)

42084 ATOMIC STRUCTURE AND SUPERCONDUCTIVITY OF V_3Ga. Kuznetsova, S. M.; Zhdanov, G. S. (Moscow State Univ.). Sov. Phys.-Cryst. (Engl. Transl.); 16: No. 6, 1077-80 (1972).

Translated from Kristallografiya; 16: No. 6, 1230-4(1971).

The atomic structure and the nature of the solid solutions formed by V_3Ga are considered. The effect of concentrational disordering and structural features on the superconducting properties of V_3Ga are explained. (auth)

42085 SUPERCONDUCTING SEMICONDUCTORS. Sniadower, Lucjan (Inst. of Physics, Warsaw). Postepy Fiz.; 23: No. 2, 157-79(1972). (In Polish).

The scope of the theory and some conclusions concerning superconductivity in low-carrier-density systems are presented. These materials: SnTe, GeTe, InTe, La_3Se_4, and $SrTiO_3$, are described from the semiconducting and superconducting point of view. The concentration dependence of critical temperature $T_c(n)$, tunneling effect and type-II superconductivity in the above-mentioned materials are presented. (auth)

42086 SURFACE SUPERCONDUCTIVITY OF THE Ti–22 AT. PERCENT Nb ALLOY. Karasik, V. R.; Vasil'ev, N. G.; Vysotskii, V. S. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1818-26(May 1972). (In Russian).

The effect of the structural states of the alloy Ti–22 at. % Nb on its critical temperature, specific resistance, critical field strengths H_{c2} and H_{c3} and critical current density of surface superconductivity near T_c is investigated. An anomalous dependence of the ratio H_{c3}/H_{c2} on temperature is detected. The dependence of the surface superconductivity critical current and the critical field strength H_{c3} on the angle between the plane of the sample and the direction of the external magnetic field is investigated. (auth)

42087 EFFECT OF JOULE HEAT ON DESTRUCTION OF SUPERCONDUCTIVITY BY A CURRENT. Dzhikaev, Yu. K. (Inst. of Physical Problems, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1918-26(May 1972). (In Russian).

The effect of the heat evolved in a sample on destruction of superconductivity by a current is considered for a cylindrical type-I superconductor. The distribution of temperature in the region occupied by the intermediate state is determined. The volt–ampere characteristics of the sample are determined. The resistance jump on transition to the intermediate state exceeds the London value which is 0.5. At current values $I \gg I_2$ the superconductivity is completely destroyed as a result of heating of the sample to the critical temperature T_c. The effect of the Kapitza temperature discontinuity at the boundary between the sample and liquid helium is considered in great detail. In particular, the cause of the converse transition to the superconducting state on decrease of the current is explained. It is found that in the presence of a Kapitza discontinuity the sample cannot exist in a stationary state in a certain temperature range (T_0, T_1) near the temperature of helium, T_0. (auth)

42088 THEORY OF THE PINNING EFFECT IN TYPE-II SUPERCONDUCTORS. Shmidt, V. V. (Inst. of Physics of Solids, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1963-73 (May 1972). (In Russian).

The interaction between superconducting vortexes and a set of cylindrical cavities (pinning) is analyzed electrodynamically.

Critical currents in a type-II superconductor located in an external magnetic field perpendicular to the current are found providing (1) the cavity set forms a wall (the cavities are parallel to each other and to the external magnetic field), (2) the cavities are at the sites of a regular square lattice, (3) pinning occurs for a set of spherical cavities forming a regular cubic lattice. (auth)

42089 INTERACTION OF ADSORBED MOLECULAR OXYGEN WITH THIN SUPERCONDUCTING ALUMINUM FILMS. Ostertag, U. (Univ., Stuttgart). Phys. Status Solidi (b); 51: No. 2, 547-53(1 Jun 1972).

Using tunnel diodes of the structure aluminum/oxide/aluminum/oxygen, a characteristic change in the density of states of thin superconducting films after covering with oxygen was found. The best fit of calculated curves to the measured characteristics was obtained for a theoretical model which assumes a pair-breaking mechanism varying locally in strength according to the local film thickness. From this fit, a maximum pair-breaking parameter and, by calculation, a maximum theoretical shift of the transition temperature is obtained. There is good agreement with the observed depression of the transition temperature. (auth)

42090 CONNECTION BETWEEN THE TRANSITION TEMPERATURE AND THE ENERGY GAP FOR SUPERCONDUCTORS WITH STRONG COUPLING. Geilikman, B. T.; Kresin, V. Z. (Moscow State Pedagogical Correspondence Inst.). Phys. Lett.; 40A: No. 2, 123-4(3 Jul 1972).

A theoretical relation between $\Delta(0)$ and T_c for superconductors with strong coupling is compared with experimental data. The essential role of the lower phonon peak is noted. The agreement is rather good. (auth)

42091 SUPERCONDUCTING ENERGY GAPS AND TRANSITION TEMPERATURES OF DISORDERED CADMIUM AND ZINC FILMS. Granqvist, C. G.; Claeson, T. (Chalmers Univ. of Tech., Goteborg). Phys. Status Solidi (a); 11: No. 2, K113-16(16 Jun 1972).

Amorphous films of Zn and Cd were quench-condensed on a quartz substrate at ≤ 2°K. T_c and $\Delta(0)$ were measured before and after annealing and the data compared with each other and with literature data. The results show that both T_c and $\Delta(0)$ are increased by about the same factor for the amorphous films, so that the ratios $2\Delta(0)/K_BT_c$ (BCS value = 3.53) are almost unchanged. (D.L.C.)

42092 SUPERCONDUCTIVITY IN THE PALLADIUM–HYDROGEN AND PALLADIUM–NICKEL–HYDROGEN SYSTEMS. Skoskiewicz, T. (Kamerlingh Onnes Lab., Leiden). Phys. Status Solidi (a); 11: No. 2, K123-6(16 Jun 1972).

Electrical resistance measurements were conducted on Pd–H and Pd–Ni (1.5 and 5 at.%)–H systems at temperatures down to 1.25°K. Before the introduction of hydrogen, the resistance of the metallic samples showed no anomalous behavior. The resistance of H/Pd = 0.87 showed a broad superconducting transition at ~4°K, and lower H concentrations led to narrower transitions at lower temperatures, with no transition observed at 1.25°K for H/Pd = 0.73. Similar behavior was found for the Pd–H systems containing 1.5 and 5 at.% Ni; no anomalous behavior was detected for 10 at.% Ni up to H/Me = 0.84. The excess conductivity ($\sigma' = \sigma - \sigma_N$) can be described by the equation $\sigma' = A \exp(-BT)$. (D.L.C.)

42093 EFFECTS CONNECTED WITH THE RESONANT BEHAVIOR OF THE GAP IN A SUPERCONDUCTOR. Ivlev, B. I. (Inst. of Theoretical Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 15: No. 7, 313-16(5 Apr 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 7, 441-5(5 Apr 1972).

The change of the equilibrium value of the gap under the influence of a weak alternating field is found. This field is assumed to be transverse and the phase Δ equal to zero. It is also assumed that everything occurs in a flat film, the thickness of which is small compared with the spatial dimensions of the variation of Δ and $\vec{A}$, so that it is possible to disregard the coordinate dependence of these quantities. It is assumed further that the number of impurities is sufficiently large to allow us to disregard the character of the electron reflection from the sample boundary. The terms due to oscillations of the modulus of the gap are shown to lead to a unique frequency dependence of the characteristics of the superconductor. (M.H.R.)

42094 SUPERCONDUCTING TRANSITION TEMPERATURE AND STRUCTURE OF MOLYBDENUM FILMS DOPED WITH CARBON. Golyanov, V. M.; Demidov, A. P.; Mikheeva, M. N.; Teplov, A. A. JETP Lett. (USSR) (Engl. Transl.); 15: No. 7, 257-9(5 Apr 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 7, 365-7(5 Apr 1972).

The properties of molybdenum films doped with carbon were investigated, using samples prepared by cathode sputtering in Kr at ~10^{-5} torr. The films were deposited on glass substrates with platinum leads. The maximum of T_c appears in the concentration range 20 to 50 at. % C, at which value the critical temperature reaches 6.9 ± 0.1°K. (M.H.R.)

PHYSICS (NUCLEAR)

42095 (CONF-720209-(Absts.)) 4th AINSE NUCLEAR PHYSICS CONFERENCE, 14–17 FEBRUARY 1972, UNIVERSITY OF SYDNEY. Abstract of Papers. (Australian Inst. of Nuclear Science and Engineering, [Lucas Heights]). 101p.

Eighty-seven abstracts dealing with various aspects of nuclear physics are presented. Topics covered are reaction theory, nuclear theory, particle physics, light, medium and heavy nuclei, reaction cross sections, nuclear structure, few-nucleon systems and experimental techniques. (Australia)

Neutron Interactions with Matter

Refer also to abstract 42383.

42096 (EUR-4414(Vol.2)) STUDIES ON NEUTRON MONOCHROMATOR CRYSTALS HAVING A LATTICE SPACING GRADIENT. Rustichelli, F. (European Communities, Brussels (Belgium). Commission). Oct 1971. 20p. (In Italian). Dep. NTIS (U. S. Sales Only). EUR Lit. 500.

The optimization criteria of the lattice spacing gradient in neutron monochromators are reported. Also, the experimental results obtained at the Institute Max von Laue-Paul Langevin in Grenoble until January 1970 in the practical production and study of crystals with a gradient in the interatomic distance are reported. (auth) (EURATOM)

42097 TWO-GROUP NEUTRON-TRANSPORT THEORY: HALF-RANGE ORTHOGONALITY, NORMALIZATION INTEGRALS, APPLICATIONS, AND COMPUTATIONS. Siewert, C. E.; Ishiguro, Y. (North Carolina State Univ., Raleigh). J. Nucl. Energy; 26: No. 5, 251-69(May 1972).

A half-range orthogonality theorem concerning the established elementary solutions of the two-group neutron transport equation for isotropic scattering and plane geometry is proved. The orthogonality relations are based on a Chandrasekhar-type H-matrix, and all necessary normalization integrals are evaluated so that the desired expansion coefficients may be expressed concisely in terms of inner products. The half-range orthogonality theorem is used to construct tractable solutions to typical half-space problems. In addition, the required H-matrix is calculated to benchmark accuracy, and explicit results for several quantities of interest are reported for the Milne, albedo and constant-source problems. (auth)

42098 DIFFUSION LENGTH OF NEUTRONS IN GRAPHITE–BISMUTH MIXTURES. Bhushan, Vidya (Safdarjang Hospital, New Delhi). J. Nucl. Energy; 26: No. 5, 271-3(May 1972).

Results are reported of calculations of diffusion length of neutrons in graphite, bismuth, and graphite-bismuth mixtures. The results are compared with experimental data of Starr and Price. [BNL-719(Vol.III) : 1034-73 (1962)]. (UK)

42099 ASYMPTOTIC P/sub N/ AND DOUBLE P/sub N/ APPROXIMATIONS. Huang, Song Teh; Lewis, E. E. (Northwestern Univ., Evanston, Ill.). J. Nucl. Energy; 26: No. 5, 231-6(May 1972).

The P_N and double P_N approximations to the monoenergetic transport equation are modified to improve their asymptotic behavior. Free parameters are introduced into the P_N and double P_N equations through the use of a pseudo-scattering kernel. The parameters are evaluated by stipulating that the resulting scalar flux approximations to the infinite-medium Green's function yield exact asymptotic solutions while conserving specified spatial moments. Asymptotic P_3 and double P_1 solutions are presented for the infinite-medium and half-space Green's functions and for the source-free and constant-source Milne problems. (auth) (UK)

42100 THEORY OF SLOW NEUTRON INELASTIC SCATTERING BY IMPURITY CRYSTALS. I. COHERENT EFFECTS OF LOCAL VIBRATIONS OF SUBSTITUTION ATOMS. Dzyub, I. P.; Kochmarskii, V. Z. (Inst. of Theoretical Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 12, 1985-96(Dec 1971). (In Russian).

An expression is obtained for the double differential cross section of slow neutron scattering by localized vibrations in crystals with the Bravais lattice when the concentration of impurities is small. It is shown that the dependence of the scattering cross section coherent part upon the neutron transfer momentum allows one to judge the force-constant matrix change. Numerical calculation of the scattering cross section is made for the model of a simple cubic lattice. (auth)

42101 INCOHERENT CROSS SECTION FOR NEUTRON QUASI-ELASTIC SCATTERING IN A LIQUID CRYSTAL. Rosciszewski, K. (Jagellonian Univ., Krakow). Acta Phys. Pol.; A41: No. 5, 549-61(May 1972).

The incoherent cross section for neutron quasi-elastic scattering in a liquid crystal is calculated. The cross section depends on the orientation of the momentum transfer vector with respect to the nematic axis. The models used correspond in the case of isotropy to the diffusion model of Vineyard and to the Singwi–Sjölander model developed by Larsson et al. (auth)

42102 STUDY OF HINDERED ROTATION IN CRYSTALS BY NEUTRON TRANSMISSION MEASUREMENTS: COMPARISON OF CALCULATED AND MEASURED SCATTERING CROSS SECTIONS. Leung, P. S. (Columbia Univ., New York. Brookhaven National Lab., Upton, N. Y.); Rush, J. J.; Taylor, T. I. J. Chem. Phys.; 57: No. 1, 175-82(1 Jul 1972).

Total neutron cross sections have been measured as a function of neutron wavelength ($\lambda_n = 5-11$ Å) and sample temperature for $(NH_4)_2SiF_6$, $(NH_4)_2S_2O_8$, durene and hexamethylbenzene. The experimental results are compared to previous cross-section data for other ammonium salts and methyl-substituted compounds and are correlated with the rotational freedom of the NH_4^+ ions and methyl groups. A relatively simple theoretical procedure is described for calculating total scattering cross sections of hydrogenous crystals using torsional and translational lattice-mode frequencies obtained from neutron or optical spectra. Cross-section variations vs wavelength ($\Delta\sigma_s/\Delta\lambda$) and temperature ($\Delta\sigma_s/\Delta T$) are calculated for a large group of ammonium salts and methyl-substituted organics (including those for which experimental cross sections are presented here) and are directly compared with measured cross section results. In every case the experimental and theoretical results agree within about 10% or less. Thus the previously observed empirical relationship between $\Delta\sigma_s/\Delta\lambda$ and $\Delta\sigma_s/\Delta T$ and the rotational and vibrational behavior of ions and molecules in solids is placed on a more quantitative basis. These comparisons reinforce the usefulness of the neutron cross-section method as a supplement to spectroscopic techniques. (auth)

42103 FAST-NEUTRON TRANSPORT IN FINITE SLABS. Santhanam, K.; Gopinath, D. V. (Bhabha Atomic Research Centre, Trombay, India). pp 95-110 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

Fast neutron transport studies using the ASFIT (Anisotropic-Source-Flux-Iteration) technique are presented. The technique solves the transport equation in the coupled integral form and can handle arbitrary degree of anisotropy in the scattering process. The materials studied are water, polyethylene, graphite and iron. Results are presented for backscattered spectra, spectra inside the slabs and transmitted dose for normal incidence of 1 and 2 MeV neutrons. The effect of finite extent of the medium on the transmitted spectra is discussed. A comparison with Monte Carlo results of Allen and Futterer is given. (auth)

42104 APPROACH TO EQUILIBRIUM OF A THERMAL NEUTRON BEAM IN A POISONED WATER ASSEMBLY. Bhushan, Vidya; Bansal, N. K. (Indian Inst. of Tech., New Delhi). pp 191-9 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

A study of the approach to equilibrium of a thermal neutron beam, in a water assembly containing various concentrations of gadolinium, has been made by solving the diffusion equation in the multigroup formalism. The Nelkin model has been used for the scattering kernel calculations. Such a type of study gives the instantaneous decay constant which approaches its fundamental value at large distances from the source. The inverse of this fundamental decay constant gives the diffusion length of the medium. The calculated values of the diffusion length agree well with the experimental values. (auth)

42105 DENSE PLASMA FOCUS AS A PULSED NEUTRON SOURCE FOR EXPERIMENTS IN REACTOR PHYSICS. Cloth, P.; Conrads, H.; Demmeler, M.; Hecker, R. (Kernforschungsanlage, Juelich, Ger.). pp 46-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The design and performance of a pulsed neutron source (repetition rate 1 Hz) are described. The device consists of a coaxial cable, which produces by magnetic compression (pinching), a plasma focus at its end. This focus contains highly energetic deuterium ions (20 to 300 keV) at a remarkable density (more than 10^{19} particles per cm^3). The neutron yield per discharge ranges between 10^9 to 10^{10}, the neutron pulse duration is about 100 nanosec and the neutron energy is 2.5 MeV. A minor component of neutrons with energies of 10.8 and 13.3 MeV results from the ^{7}Li (p,n) reaction: a strong x-ray flash also emerges simultaneously. Possible improvements of the device are mentioned and further applications (including activation of short-lived isotopes, neutronography etc.) of this neutron source are indicated. (auth)

42106 EVALUATION OF NUCLEAR DATA IN THE MeV RANGE. Meyer, R. (Kernforschungszentrum, Karlsruhe, Ger.). pp 86-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

In the course of evaluation of nuclear data for the Karlsruhe nuclear data file KEDAK the data for the five materials Na, Cr, Fe, Ni and Mo have been reevaluated within the MeV region. After an introductory consideration of the questions "Why evaluation" and "What is evaluation", the problems and methods of evaluation are described which are typical for the energy range considered and which, on the other hand, may also occur in other evaluation procedures. (INIS)

42107 DIFFRACTION OF COLD NEUTRONS BY FERROMAGNETIC BLOCH WALLS: ELASTIC SCATTERING. Bushev, M. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 6, 710-16(1971). (In Russian).

Traditional methods of irradiating domain structure yield chiefly information concerning the surface of the sample. Neutron beams render "transparent" the ferromagnetic domains and make possible a study of the structure in the interior of the sample. The cross section of elastic scattering of cold neutrons was found for plane parallel domain structure allowing for the internal structure of a ferromagnetic Bloch wall. The experimental method is elucidated. For the majority of materials it is possible to observe a diffraction pattern only for a structural period of $1 \lesssim 10^{-5}$ cm. (tr-auth)

Nuclear Properties and Reactions, A ≤ 5

Refer also to abstract 41993.

42108 (CEA-CONF-1975) STUDY OF THE NEUTRON-NEUTRON INTERACTION FROM THE n + d BREAK-UP PROCESS. Bouchez, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires. Grenoble Univ. (France). Institut des Sciences Nucleaires). Dec 1971. 20p. (CONF-710708-5). Dep. NTIS (U. S. Sales Only).

From Symposium on the nuclear three body problem and related topics; Budapest, Hungary (7 Jul 1971).

Some analyses of neutron-neutron final-state interactions made using separable models and the Faddeev equations are reviewed. The analyses include both complete and incomplete experiments on the n-n interaction from the n + d breakup reaction. (J.W.R.)

42109 CALCULATION OF THE BINDING ENERGY AND WAVE FUNCTION OF ^{3}He BY THE HARMONIC POLYNOMIAL METHOD. Kharchenko, V. F.; Kuz'michev, V. E. (Inst. of Theoretical Physics, Kiev. Inst. of Nuclear Research, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 11, 1829-37(Nov 1971). (In Russian).

The problem of the bound state of the system consisting of two protons and one neutron (nucleus ^{3}He) with the central interaction between nucleons is considered using the expansion of the wave function in terms of the harmonic polynomials. The Coulomb interaction between nucleons which causes the state with isospin $T = 3/2$ to be admixed into the ^{3}He wave function is taken into account. In the approximation taking into consideration the harmonics with K = 0 and K = 2 the binding energies and wave functions of ^{3}He are calculated for the square-well potential. On the basis of the obtained wave function, the values for the probabilities of the S′ states with $T = 1/2$ and with $T = 3/2$, electromagnetic form factors, and root-mean-square radii are obtained. (auth)

42110 S'- AND D-STATE EFFECTS IN ^{3}He FORM FACTORS AND IN p-^{3}He ELASTIC SCATTERING CROSS-SECTION. Samaranayake, V. K. (International Centre for Theoretical Physics, Trieste, Italy); Wilk, G. Lett. Nuovo Cim.; 4: No. 1, 27-32(6 May 1972).

The charge form factor of ^{3}He was calculated using a ground-state wave function containing S, S′, and D states given in terms of Gaussian functions. The magnetic form factor was estimated using the parameters fitted to the charge form factor. A similar wave function was used to study p-^{3}He elastic scattering by Glauber theory. The wave functions including the S′ and D states gave good fits to the experimental data for the form factors and the p-^{3}He scattering. (J.W.R.)

42111 ELASTIC SCATTERING OF POLARIZED PROTONS BY ^{3}H BETWEEN 19 AND 57 MeV. Darves-Blanc, R.; Nguyen Van Sen; Arvieux, J.; (and others) (Institut des Sciences Nucleaires, Grenoble, France). Lett. Nuovo Cim.; 4: No. 1, 16-18 (6 May 1972).

Cross sections and asymmetries for the elastic scattering of polarized protons by tritium were measured at 19, 30, and 40.5 MeV. The cross sections for elastic scattering and the ^{3}H(p,n) charge exchange reaction were also measured at 56.7 MeV. The results were compared with previous data. (J.W.R.)

42112 ANALYZING POWER AT 45° FROM 1.5 TO 12 MeV FOR THE REACTION T(p,n)^{3}He. Haight, R. C. (Los Alamos Scientific Lab., N. Mex.); Jarmer, J. J.; Simmons, J. E.; Martin, J. C.; Donoghue, T. R. Phys. Rev. Lett.; 28: No. 24, 1587-90(12 Jun 1972).

The analyzing power A of the reaction T(p,n)^{3}He has been measured at 45° c.m. from 1.5 to 12 MeV with a polarized proton beam. A comparison with existing data for the neutron polarization P shows that P and A have similar excitation functions at this angle, but that the magnitude of P is generally less than that of A. While the R-matrix formalism does not require exact equality between P and A, at present a successful explanation of the observed differences is not available. (auth)

42113 NEUTRON-NEUTRON $^1S_0$ SCATTERING PARAMETERS FROM A KINEMATICALLY COMPLETE EXPERIMENT ON THE REACTION ^{2}H(n,2n)H. Zeitnitz, B. (Univ., Hamburg); Maschuw, R.; Suhr, P.; Ebenhoeh, W. Phys. Rev. Lett.; 28: No. 25, 1656-8(19 Jun 1972).

In a complete experiment on the reaction ^{2}H(n,2n)H observed neutron-neutron and neutron-proton final-state interactions were observed. The analysis by a three-body calculation with separable potentials gives $a_{nn} = -14.5 \pm 0.8$ fm for the $^1S_0$ neutron-neutron scattering length and $r_{nn} = 2.7 \pm 0.5$ fm for the effective range. (auth)

42114 ^{4}He(e,d)e′^{2}H ANGULAR-DISTRIBUTION AND CROSS-SECTION MEASUREMENTS BETWEEN 36 AND 50 MeV. Skopik, D. M. (American Univ., Washington, D. C.); Dodge, W. R. Phys. Rev., C; 6: No. 1, 43-53(Jul 1972).

Measurements of the angular distributions in the "virtual photon" energy interval of 40 ± 1 MeV and the total cross section in the energy interval of 35.7-49.4 MeV of the ^{4}He(e,d)e′^{2}H reaction are presented. The data are compared with early calculations and with more recent cluster-model and dispersive calculations. (auth)

42115 NEUTRON-DEUTERON ELASTIC SCATTERING ABOVE THE BREAKUP THRESHOLD. McDonald, F. A. (Southern Methodist Univ., Dallas); Nuttall, J. Phys. Rev., C; 6: No. 1, 121-5(Jul 1972).

Amplitudes for elastic s-wave neutron-deuteron scattering above the breakup threshold are calculated by the method of complex coordinates. The nucleon-nucleon interaction is represented by a local spin- and parity-dependent central Yukawa potential, with parameters chosen to fit low-energy two-nucleon data. Results for inelastic parameters indicate possible errors in a previous phase-shift analysis. Results for the quartet phase shift and quartet and doublet inelastic parameters are consistent with separable potential calculations, but the doublet phase shifts from the two models differ significantly. (auth)

42116 SHELL-MODEL ANALYSIS FOR BRUECKNER CALCULATIONS IN LIGHT NUCLEI. Tripathi, Ram K.; Goldhammer, Paul (Univ. of Kansas, Lawrence). Phys. Rev., C; 6: No. 1, 101-13(Jul 1972).

Brueckner self-consistent calculations are performed for ^{16}O, ^{3}H, and ^{4}He nuclei with various modern hard-core interactions. Elements of the G matrix are calculated by the reference-spectrum method, while Q - 1 corrections are made by matrix inversion in the proper single-particle space. Thus, it is not assumed that Q commutes with the center-of-mass motion. The prescription for selecting the appropriate spectrum of single-particle excited states is investigated by comparing results of the Brueckner method with other calculations. These comparisons indicate that the particle spectrum should be left unperturbed. One then finds that the Hamada-Johnston, Yale, and Reid (hard-core) interactions yield about one half the binding energy of ^{16}O. The calculated results are dissected into shell-model components. This analysis indicates that the short-range part of the hard-core interaction is too strongly repulsive. (auth)

42117 MEASUREMENTS OF D(d,$\vec{n}$)^{3}He NEUTRON POLARIZATIONS FOR DEUTERON ENERGIES FROM 0.87 TO 5.00 MeV.

Smith, J. R.; Thornton, S. T. (Univ. of Virginia, Charlottesville). Can. J. Phys.; 50: No. 8, 783-90(15 Apr 1972).

Neutron time-of-flight techniques were used to measure $D(d,\vec{n})^{3}He$ polarization angular distributions for several deuteron energies from 0.87 to 5.00 MeV. Liquid helium served as the polarized neutron analyzer. From Legendre polynomial expansions of $\sigma(\Theta)$ and $P(\Theta)\sigma(\Theta)$, contour maps of $P(\Theta)$ and $P^{2}(\Theta)\sigma(\Theta)$ were produced for the energy range 0.87 to 5.00 MeV. Comparison with previous results and measurement techniques are discussed. Nucleon polarizations from the charge symmetric reactions $D(d,\vec{n})^{3}He$ and $D(d,\vec{p})T$ are compared. (auth) (Canada)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 41837, 42116, 42144, 42231, and 42233.

42118 (EANDC(E)-148(U)) STUDY OF THE ^{6}Li(n,α)T EFFECTIVE CROSS SECTION IN THE ENERGY RANGE BETWEEN 20 keV AND 1700 keV. Fort, E.; Marquette, J. P. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). 5 Jan 1972. 42p. (In French). Dep. NTIS (U.S. Sales Only).

The ^{6}Li(n,α)T reaction cross section has been deduced from the measurement of the efficiency of a Lithium glass scintillator, relative to a calibrated flat response counter in a monoenergetic neutron beam. Time of flight is used to separate direct neutrons from those scattered by the target backing. The flat response counter is calibrated relative to a SO^{4}Mn bath. The values of the ^{6}Li(n,α)T cross section obtained are in agreement with those obtained previously by the associated particle technique, and with some recent evaluations below 100 keV. The R-Matrix formalism has been used to fit with a single set of parameters the results of this experiment and the total cross section and angular distributions measured by other laboratories. (auth)

42119 (FRNC-TH-186) STUDY OF NUCLEAR LEVELS OF ^{19}F AND ^{20}Ne USING THE ^{18}O(d,n)^{19}F AND ^{18}O(^{3}He,n)^{20}Ne REACTIONS. Tamisier, Roland (Nantes Univ. (France)). 1971. 120p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The spectroscopic characteristics of certain ^{19}F and ^{20}Ne levels were determined from studies of the time-of-flight spectrum and the form of the angular distribution of the neutrons produced during the ^{18}O(d,n)^{19}F, and ^{18}O(^{3}He,n)^{20}Ne reactions. The analysis was completed by studying the γ spectra associated with the ^{18}O(d,n)^{19}F reaction. The mechanism involved in these reactions was interpreted as a transfer of one or two protons in the framework of the DWBA. The spectroscopic results are discussed in terms of different models in the cases where it was possible to determine the proton capture moment, L, without ambiguity. (France)

42120 (LA-4851) ^{9}Be(d,n)^{10}B CROSS SECTION IN THE RANGE 0 TO 2.8 MeV. Devaney, J. J. (Los Alamos Scientific Lab., N. Mex.). May 1972. Contract W-7405-eng-36. 4p. Dep. NTIS.

The total ^{9}Be(d,n)^{10}B, ^{10*}B cross section is constructed by theoretically completing an experimental partial absolute cross section and using it to normalize a relative measurement which in turn was extrapolated to below 0.5 MeV by the relative energy dependence of the Coulomb penetration factor. (auth)

42121 (LYCEN-7173) FEATURES OF THE π NUCLEAR SCATTERING AT LOW ENERGY. Ericson, M.; Krell, M. (Lyon Univ. (France). Institut de Physique Nucleaire). Sep 1971. 12p. Dep. NTIS (U.S. Sales Only).

The behavior of π nuclear scattering at low energies (<100 MeV) is discussed. It is predicted that with relatively light nuclei, the s wave interaction can undergo a sign change from repulsion to attraction due to the growing influence of the nonlocal interaction. It is possible that size resonance exists in the s and p partial wave amplitudes. (France)

42122 STUDY OF ^{16}O(d,d)^{16}O AND ^{16}O(d,p)^{17}O USING POLARIZED DEUTERONS. Corrigan, K. W. (Univ. of Notre Dame, Ind.); Prior, R. M.; Darden, S. E.; Robson, B. A. Nucl. Phys.; A188: No. 1, 164-84(1972).

Cross sections and vector and tensor analyzing powers were measured for ^{16}O(d,d)^{16}O(d,p_0)^{17}O, and ^{16}O(d,p_1)^{17}O* at bombarding energies of 9.3 and 13.3 MeV. For the elastic scattering, cross-section and vector-analyzing-power data are reasonably well reproduced by optical-model calculations, but only rough qualitative agreement with the tensor analyzing power is obtained. Some improvement in the agreement with the tensor-analyzing-power data results if a tensor term T_R is included in the optical potential. A degree of correspondence with the (d,p_0) data at 9.3 MeV is achieved using DWBA calculations which take into account the D state of the deuteron and the tensor potential, T_R. For $E_d = 13.3$ MeV, the general features of all the (d,p_1) data except T_{21} (θ) can be realized using only an $l \cdot s$ spin dependence in the optical potentials. Nonstripping mechanisms appear to be operative in the (d,p) reactions, particularly at the lower energy. (10 figures, 2 tables) (auth)

42123 ELASTIC AND INELASTIC SCATTERING OF 7 TO 11 MeV PROTONS FROM ^{14}N. Messelt, S. (Univ. of Oslo). Phys. Norv.; 4: No. 3-4, 191-216(1970).

The differential cross sections for elastic and inelastic scattering of 7 to 11 MeV protons from ^{14}N have been measured at 30, 60, 90 and 120° using the Wisconsin tandem accelerator and a differential pumped gas scattering chamber. Cross sections for the reactions ^{14}N(p,^{3}He)^{12}C to g.s. and ^{14}N(p,α)^{11}C to g.s. and 1st exc. state were also determined. At four energies the angular distribution of the particle groups was measured in more detail. The excitation curves indicate appreciable compound nucleus formation with peaks interpreted as largely due to ^{15}O states. The (p,α) cross sections are much larger than the other inelastic cross sections in the energy region 7 to 8 MeV, and sharp resonances appear superposed on a broad resonance. The elastic angular distributions together with earlier reported measurements at 9.73 MeV have been analyzed in terms of the optical model. Several parameter sets giving satisfactory fits to all data except at the lowest energy, 7.53 MeV, were found. Predicted polarization values are in good agreement with reported measurements at 8 and 10.4 MeV. (auth)

42124 ^{12}C(n,n'γ)^{12}C ANGULAR-CORRELATION MEASUREMENTS AT FORWARD SCATTERING ANGLES. DeLeo, R.; D'Erasmo, G.; Ferrero, F.; Pantaleo, A. (Univ., Bari, Italy). Lett. Nuovo Cim.; 4: No. 3, 87-90 (20 May 1972).

Neutron-gamma angular correlations for the ^{12}C(n,n'γ) reaction were measured at $E_n = 13.9$ MeV for forward scattering angles. Some conclusions drawn from the results are presented. (J.W.R.)

42125 PHOTOPRODUCTION OF ^{7}Be FROM CARBON, BORON, BERYLLIUM, AND LITHIUM. Noga, V. I.; Ranyuk, Yu. N.; Sorokin, P. V.; Tkachenko, V. A. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 11, 1850-4 (Nov 1971). (In Russian).

The nuclide ^{7}Be was produced by irradiating carbon, boron, beryllium and lithium with bremsstrahlung from the Kharkov electron linear accelerator. Yield curves are measured and cross sections are calculated for photons up to 1180 MeV. (auth)

42126 CORRECTION TO A VARIATION CALCULATION OF ^{16}O BINDING ENERGY. Maksimenko, V. M. (Inst. of Theoretical Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 11, 1785-7(Nov 1971). (In Russian).

Calculation of the second order correction of the perturbation theory to the variation binding energy of nucleus ^{16}O is made for a concrete variant of pair forces which provide for saturation. The allowance for the correction essentially improves agreement with the experiment. Comparison of the results of the correction for the nuclei ^{4}He and ^{16}O is made. (auth)

42127 MEASUREMENT OF α-PARTICLE AND PROTON WIDTHS OF THE 2263 keV ^{18}O + p RESONANCE AND CONSEQUENT REINTERPRETATION OF, LARGE γ-RAY AND α-PARTICLE REDUCED WIDTHS OF THE 2260 keV ^{18}O + p RESONANCE. Wormald, M. R. (Oxford Univ.); Wright, I. F. Particles Nucl.; No. 5, 253-63(May 1972).

Measurements on the ^{15}N(α,γ)^{19}F reaction show no sign of a resonance corresponding to the 2263 keV resonance in ^{18}O(p,γ)^{19}F ($E_x = 10136$ keV) and hence that $\Gamma_\alpha \ll \Gamma_p$ for this resonance. Measurements of the ^{18}O(p,p)^{18}O yield at 90° confirm that this resonance has a large value of Γ_p and hence that previous results which were taken to imply that $\Gamma_p/\Gamma \ll 1$ are due to interference between two levels of nearly equal energies and widths. The previously published γ-ray and α-particle widths must, therefore, be reduced by a factor of 30. A ^{15}N(α,γ) resonance decaying to the 1346 and 1459 keV levels in ^{19}F shows that there is a third closely spaced level at $E_x = 10127$ keV. (auth)

42128 SELECTIVE EXCITATION OF ONE-, TWO-, AND THREE-NUCLEON CONFIGURATIONS IN TRANSFER REACTIONS INDUCED BY HEAVY IONS. Scott, D. K. (Oxford Univ.); Hudson, P. N.; Fisher, P. S.; (and others). Phys. Rev. Lett.; 28: No. 25, 1659-62(19 Jun 1972).

A study is reported of one-, two-, and three-nucleon transfer reactions induced by 114-MeV ^{12}C ions on targets of ^{12}C, ^{16}O, and ^{40}Ca. A prominent feature is the extreme selectivity of the reaction mechanism in exciting simple one-, two-, and three-particle stretched configurations in the residual nuclei. (auth)

42129 RESONANCE IN ^{12}C + ^{16}O SCATTERING AT $E_{c.m.} \approx$ 19.7 MeV. Malmin, R. E. (Argonne National Lab., Ill.); Siemssen, R. H.; Sink, D. A.; Singh, P. P. Phys. Rev. Lett.; 28: No. 24, 1590-3(12 Jun 1972).

A strong resonancelike structure (~400 keV wide) has been observed in elastic ^{16}O + ^{12}C scattering. Inelastic scattering excitation functions with ^{16}O in the unresolved 0^+, 3^- states at 6.1 MeV show structure correlated with the elastic channel. An analysis of the angular distribution measured on the resonance indicates a spin $I = 14$. (auth)

42130 HARTREE–FOCK CALCULATIONS FOR DOUBLE-CLOSED-SHELL NUCLEI USING THE MODIFIED DELTA INTERACTION. Ehlers, Jerry W.; Moszkowski, Steven A. (Univ. of California, Los Angeles). Phys. Rev., C; 6: No. 1, 217-27(Jul 1972).

Properties of double-closed-shell nuclei are calculated using the Hartree–Fock method. The effective nucleon–nucleon interaction is taken to be the density-dependent "modified δ interaction," which is closely related to the Skyrme interaction, but with only three free parameters. These parameters were chosen so as to reproduce, as well as possible, the binding energy and rms charge radii of ^{16}O and ^{208}Pb. This interaction leads to a binding energy 16.5 MeV/A and Fermi momentum 1.33 fm^{-1} of nuclear matter. Good agreement is found with the empirical rms charge radii of the other double-closed-shell nuclei, ^{40}Ca, ^{48}Ca, and ^{90}Zr. The same holds for the single-particle removal energies, especially those from 1s levels. The Hartree–Fock calculations with the present spin-independent and s-state interaction leads to as good agreement with experiment as those made by others, in particular, those made by Vautherin and Brink, who used a Skyrme interaction with five parameters. The differences between the Skyrme and modified δ interaction are discussed. It is pointed out that the effective mass of a nucleon depends strongly on the odd-state part of the interaction, while the asymmetry potential is also sensitive to its spin dependence. (auth)

42131 ^{19}F(d,p)^{20}F AND THE NUCLEAR STRUCTURE OF ^{20}F. Fortune, H. T. (Argonne National Lab., Ill. Univ. of Pennsylvania, Philadelphia); Morrison, G. C.; Bearse, R. C.; Yntema, J. L.; Wildenthal, B. H. Phys. Rev., C; 6: No. 1, 21-9(Jul 1972).

The reaction ^{19}F(d,p)^{20}F has been studied with 16-MeV deuterons. Outgoing protons were detected in photographic emulsions in a magnetic spectrograph. Spectroscopic factors were extracted and combined with previous information and compared with results of shell-model calculations performed in a complete sd-shell basis. Of the previously known 25 states below $E_x = 4.5$ MeV, angular distributions measured at 14 angles were obtained for all but the 5 at $E_x = 1.824$, 2.871, 3.761, 4.20, and 4.21 MeV. Strong stripping angular distributions were observed for 10 states — 6 dominated by $l = 2$, and 4 by $l = 0$. These 10 states agree reasonably well in position and strength with the 10 lowest shell-model states predicted to have appreciable amounts of the configuration [^{19}F(g.s.) $\otimes$ $1d_{5/2}$ or $2s_{1/2}$ (neutron)]. (auth)

42132 ISOSPIN IMPURITY OF THE 6.88-MeV STATE IN ^{10}B. Renan, M. J.; Sellschop, J. P. F.; Keddy, R. J.; Mingay, D. W. (Univ. of the Witwatersrand, Johannesburg). Phys. Rev., C; 6: No. 1, 12-17(Jul 1972).

The γ-ray yield for the reaction ^{9}Be(p,γ)^{10}B has been measured over the range of bombarding energies 0.20–0.85 MeV and the radiative decay of the 6.88-MeV resonance level in ^{10}B studied. A large nonresonant contribution to the reaction cross section has been identified and compared with calculated cross sections based on an extranuclear direct-capture process. The previously measured high isospin impurity of the 6.88-MeV state is consequently significantly reduced; the amplitudes for the $T = 0$ and $T = 1$ parts of the wave function for this state are determined to be 0.92 and 0.39, respectively. (auth)

42133 REACTION ^{6}Li(p,pd)^{4}He AT 590 MeV AND α–d CLUSTERING IN ^{6}Li. Alder, J. C. (Coll. of William and Mary, Williamsburg, Va.); Dollhopf, W.; Kossler, W.; (and others). Phys. Rev., C; 6: No. 1, 18-21(Jul 1972).

The cross section for the reaction ^{6}Li(p,pd)^{4}He(g.s.) has been measured in a kinematically complete experiment with 590-MeV protons. Reactions with recoil momenta of the residual ^{4}He nucleus up to 120 MeV/c have been detected. The results are interpreted in terms of the plane-wave impulse approximation and the α–d cluster model. It is found that the reaction occurs with a cross section 0.8 times as large as the free elastic pd cross section at the same average c.m. scattering angle. The width of the momentum distribution for the motion of a deuteron in ^{6}Li is observed to be 124 ± 4 MeV/c (full width at half maximum), a value considerably larger than had been observed before in similar experiments at lower energies. (auth)

42134 PARITY OF THE FIRST UNBOUND STATE IN ^{14}N. Balamuth, D. P.; Noe, J. W. (Univ. of Pennsylvania, Philadelphia,. Phys. Rev., C; 6: No. 1, 30-3(Jul 1972).

A weak radiative decay from the proton-unbound level at 7.966-MeV excitation in ^{14}N has been observed by coincident detection of protons and γ rays from the reaction ^{12}C(^{3}He,pγ)^{14}N. Using the previously known decay scheme the width ratio Γ_γ/Γ is measured as (0.7 ± 0.2)% from the observed coincidence yield. This result together with the reported value of $\omega\Gamma_p\Gamma_\gamma/\Gamma$ implies $(2J+1)\Gamma_p = 12.6 \pm 3.6$ eV. Comparison of the present value of Γ_p with measurements involving the reaction ^{13}C(^{3}He,d)^{14}N implies $l_p = 2$ for the (^{3}He,d) transition leading to the 7.966-MeV state, and consequently establishes the parity of that state as negative. (auth)

42135 HOW GOOD IS THE HARTREE–FOCK APPROXIMATION FOR ^{16}O. Parikh, J. C. (Univ. of Rochester, N. Y. Physical Research Lab., Navrangpura, India); Svenne, J. P. Phys. Rev., C; 6: No. 1, 34-8(Jul 1972).

Hartree–Fock intrinsic states in ^{16}O are examined to find out the extent to which they are good approximations to the exact eigenstates of the system. For this purpose the notion of width of a state is used. In terms of the width it is found that by itself the Hartree–Fock approximation is not good in ^{16}O, however it does provide a suitable basis to discuss the structure of the low-lying states. The calculation of the 0^+ levels confirms earlier suggestions made regarding the nature of these levels and is also in agreement with exact calculations done in a small basis space. (auth)

42136 CALCULATION OF THE $T = 0$ LEVELS OF ^{18}F USING ONE-BOSON-EXCHANGE POTENTIALS. Ganas, P. S. (California State Coll., Los Angeles). Phys. Rev., C; 6: No. 1, 38-43 (Jul 1972).

The low-lying $T = 0$ energy levels of ^{18}F are calculated in the harmonic-oscillator shell model using several velocity-dependent one-boson-exchange potential models of the nucleon-nucleon interaction. In these calculations the following are neglected: (a) the short-range correlations which, if they were included, would suppress the repulsive core; and (b) core-polarization effects, which take account of the excitations of the ^{16}O core. It is found that the shell-model matrix elements are too repulsive, and the energy levels lie too high. In general, good fits to the experimental levels are obtained after reducing the ω-meson coupling constant to compensate for the neglect of the effects (a) and (b). (auth)

42137 GIANT RESONANCES IN ^{12}C. Brassard, C.; Shay, H. D.; Coffin, J. P.; Scholz, W.; Bromley, D. A. (Yale Univ., New Haven). Phys. Rev., C; 6: No. 1, 53-75(Jul 1972).

Detailed measurements on the reaction ^{11}B(p,γ)^{12}C are reported in the incident proton energy range $14 \le E_p \le 22$ MeV. Previously reported absolute cross sections for this reaction have been found to be in question. Measurements have been made leading to the first (2^+) and third (3^-) states of ^{12}C in addition to the ground state. No evidence has been found for the predicted resonance at $E_x = 35$ MeV, also reported in earlier experimental work. Detailed calculations based on the one-particle–one-hole model wave functions of Gillet and Vinh-Mau have been compared with the experimental data using a complete R-matrix formalism. Repetition of these calculations using pure j–j configurations yields comparable agreement. Evidence for the importance of many-particle–many-hole configurations in the radiative capture process has been found, particularly in the reaction leading to the first and third excited states, but also in the ground-state reaction data. The calculations are significant in the sense that no new parameters are introduced, nor are any significant approximations used which are not already in the model wave functions under test. The isospin mixing in ^{12}C is found to be very small, if the new absolute (p,γ_0) cross section reported here is used; this is in marked contrast to earlier estimates of this mixing. (auth)

42138 STATES IN ^{15}O BETWEEN 8.8 AND 9.0 MeV EXCITATION. Krone, R. W.; Fiarman, S. (Univ. of Kansas, Lawrence). Phys. Rev., C; 6: No. 1, 95-100(Jul 1972).

The reaction ^{14}N(p,γ)^{15}O was used to examine the resonance structure in ^{15}O between 8.8 and 9.0 MeV. The resonance previously reported at $E_p = 1.742$ MeV was found to have two components corresponding to excitations in ^{15}O of 8.920 and 8.925 MeV, respectively. The decay properties of these two levels were studied with high-resolution Ge(Li) detectors, showing that they closely resemble the properties of probable mirror levels at 9.23 and 9.155 MeV in ^{15}N. (auth)

42139 COMMENT ON A POSSIBLE $J^\pi = 0^+$, $T = 2$ RESONANCE IN ^{9}Be(^{3}He,$\gamma\gamma$)^{12}C. Warburton, E. K. (Brookhaven

National Lab., Upton, N. Y.); Kuan, H. M.; Alburger, D. E.; Paul, P.; Snover, K. A. Phys. Rev., C; 6: No. 1, 375-7(Jul 1972).

The reaction $^9Be(^3He,\gamma\gamma)^{12}C$ has been reexamined near a previously reported resonance at $E_{^3He} = 1.739 \pm 0.007$ MeV, which was ascribed to the lowest T = 2 state in ^{12}C. No resonance was observed and an upper limit $\Gamma_{^3He}\Gamma_\gamma/\Gamma < 1.5$ MeV is established for the T = 2 resonance strength (assuming $\Gamma \leq 1.5$ keV) which is $1/_5$ of the previously reported strength. (auth)

42140 β-DELAYED PROTON DECAY OF ^9C. Esterl, John E.; Allred, David; Hardy, J. C.; Sextro, R. G.; Cerny, Joseph (Univ. of California, Berkeley). Phys. Rev., C; 6: No. 1, 373-5 (Jul 1972).

The delayed-proton spectrum following the β decay of $^9C(\tau_{½} = 126.5 \pm 1.0$ msec) was found to consist primarily of a continuum extending from 13 to 1.5 MeV, the latter being the lowest energy observed. In addition to the previously observed peaks at 9.28 and 12.30 MeV (c.m.), possible peaks between 3 and 7 MeV have been tentatively identified. (auth)

42141 MEASUREMENTS OF THE NEUTRON MULTIPLICATION FACTOR OF Be AND BeO AND OF THE Be(n,2n) CROSS SECTION WITHIN THE THRESHOLD REGION (2.4 TO 3.4 MeV). Bloser, M.; Demmeler, M.; Kirch, N.; Krings, F. J. (Kernforschungsanlage, Juelich, Ger.). pp 90-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

In the course of developing special reactor concepts, such as high temperature reactors or space reactors, the use of beryllium and of beryllium oxide has been discussed. In this connection the (n,2n) reaction in beryllium, occurring after irradiation with fast neutrons, is of special importance. Therefore, the multiplication factors in beryllium and beryllium oxide and the excitation function for the reaction $^9Be(n,2n)$ within the threshold region are determined using a scintillator tank and a pulsed DT neutron source. (INIS)

42142 ENERGY DEPENDENCE OF ELASTIC SCATTERING OF PROTONS BY CERTAIN NUCLEI USING THICK TARGETS. Galakhmatova, B. S.; Kalacheva, Z. F.; Omar, M. R.; (and others). Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 6, 637-41 (1971). (In Russian).

The continuous energy dependence of the cross section of elastic scattering of protons was investigated by the method of thick targets. Measurements were conducted with a cyclotron with a fixed beam energy ($E_p = 6.5$ MeV). Excitation functions were determined for C, Si, and Ca for $U_{lab} = 120°$. (tr-auth)

42143 TOTAL NEUTRON CROSS SECTION OF ^6Li FROM 100 TO 1500 keV. Meadows, J. W.; Whalen, J. F. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 48: No. 2, 221-4(Jun 1972).

The neutron total cross section of ^6Li was measured at 100 to 1500 keV with a resolution of 2.5 to 3 keV. Corrections were made for the presence of ^7Li in the samples and for neutron scattering at the source. The results are compared with previous data. (J.W.R.)

Nuclear Properties and Reactions, 20 ≤ A ≤ 38

Refer also to abstracts 41837, 42119, 42131, 42142, 42165, 42231, and 42246.

42144 (COO-3494-2) NUCLEAR REACTION MECHANISMS. Progress Report, May 1971–April 1972. Blann, Marshall (Rochester Univ., N. Y. Dept. of Chemistry). 1972. Contract AT(11-1)-3494. 40p. Dep. NTIS.

New results are reported in preequilibrium decay models. These include new formulations such that absolute spectral yields may be calculated rather than just relative spectral distributions. Additionally, it is shown that the nuclear density distribution is an important consideration in preequilibrium decay for several different reasons. New results on intermediate state densities as used in the preequilibrium decay models are presented. The results to date involve calculation of these densities using Nilsson single particle levels rather than equally spaced single particle levels. Results are also reported for the heavy ion-fusion cross section/elastic scattering program. Some of the final results are presented; theoretical analysis is still in progress. Publications, addresses, and colloquia for the year, covering work on the subject contract, are also summarized. (auth)

42145 (INP–740) ENERGY VARIATION OF THE ELASTIC SCATTERING OF ALPHA PARTICLES ON Mg, Si, Ca, AND Co NUCLEI IN THE ENERGY RANGE FROM 23.5 TO 28.5 MeV. Budzanowski, A.; Chyla, K.; Grotowski, K.; (and others) (Institute of Nuclear Physics, Krakow (Poland)). 1972. 99p. Dep. NTIS (U. S. Sales Only).

Differential cross sections for elastic scattering of alpha particles on Mg, Si, Ca, Co and Au nuclei have been measured at alpha particle energies in the range from 23.5 to 28.5 MeV in 0.5 MeV steps. Measurements were performed from about 25 up to 179° in lab system. Pronounced resonances in the scattering at backward angles were found for Mg, Si and Co nuclei. (auth)

42146 (INP–779) COUPLED CHANNELS ANALYSIS OF ALPHA-PARTICLES SCATTERED FROM ^{28}Si AND ^{32}S NUCLEI. Szymakowski, J.; Wojciechowski, H.; Zubik, S.; Korban, O. (Institute of Nuclear Physics, Krakow (Poland)). 1972. 21p. Dep. NTIS (U. S. Sales Only).

The measured elastic and inelastic scattering of 26.5-MeV alpha particles from ^{28}Si and ^{32}S nuclei has been analyzed using the coupled-channels model. The quadrupole and hexadecapole deformation parameters for ^{28}Si were found. The predictions for ^{32}S nuclei assuming rotational and vibrational mode of excitations are very similar, and the same value for the deformation parameter was found from both models. (auth)

42147 (KURRI-TR–95) MEASUREMENT OF THE AVERAGED THRESHOLD REACTION CROSS SECTION WITH A FISSION PLATE. Chatani, Hiroshi; Kanda, Keiji; Shibata, Toshikazu (Kyoto Univ. (Japan). Research Reactor Inst.). 1972. 7p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The threshold reaction cross section averaged over the fission neutron spectrum was measured with a 90% enriched uranium converter in combination with the heavy water thermal neutron facility of Kyoto University Reactor (KUR), and the obtained cross sections were normalized with the value of: 0.61 mb for $^{27}Al(n,\alpha)^{24}Na$ reaction. The results are: $^{27}Al(n,p)^{27}Mg$: 3.57 ± 0.04 mb, $^{24}Mg(n,p)^{24}Na$: 1.28 ± 0.04 mb, $^{55}Mn(n,2n)^{54}Mn$: 0.19 ± 0.04 mb, $^{58}Ni(n,p)^{58}Co$: 112 ± 3 mb, $^{103}Rh(n,n')^{103m}Rh$: 566 ± 23 mb, $^{115}In(n,n')^{115m}In$: 171 ± 5 mb, $^{204}Pb(n,n')^{204m}Pb$: 15.5 ± 0.4 mb respectively. The measured cross sections have been compared with the values of former experiments. In most cases there are good agreements among these values. (auth)

42148 (UCRL-Trans–10603) MEASUREMENTS OF SOME CAPTURE CROSS SECTIONS FOR FAST NEUTRONS. Colditz, J.; Hille, P. Translated for Univ. of California Lawrence Livermore Lab., Livermore, from Oesterr. Akad. Wiss. Math.-Naturwiss. Kl., Anz.; 105: No. 1, 237-41(1968). 7p. Dep. NTIS.

At a neutron energy of 2.9 ± 0.2 MeV some effective cross sections of (n,γ)-reactions were determined as follows: $\sigma^{26}Mg(n,\gamma) = 0.21 \pm 0.03$ mb; $\sigma^{27}Al(n,\gamma) = 0.30 \pm 0.05$ mb; $\sigma^{37}Cl(n,\gamma) = 0.59 \pm 0.09$ mb; $\sigma^{51}V(n,\gamma) = 1.4 \pm 0.2$ mb; $\sigma^{55}Mn(n,\gamma) = 2.2 \pm 0.2$ mb; $\sigma^{65}Cu(n,\gamma) = 6.2 \pm 0.8$ mb; $\sigma^{68}Zn(n,\gamma) = 2.6 \pm 0.4$ mb (measurement of the 55 min activity); $\sigma^{75}As(n,\gamma) = 14.0 \pm 1.4$ mb; $\sigma^{115}In(n,\gamma) = 68 \pm 11$ mb (measurement of the 54 min activity); $\sigma^{127}I(n,\gamma) = 42.8 \pm 5.0$ mb; $\sigma^{138}Ba(n,\gamma) = 3.0 \pm 0.4$ mb. All effective cross section determinations resulted following the activation method relative to the cross section $\sigma^{115}/_n(n,n'\gamma)^{115m}/_n = 360$ mb. For the production of faster neutrons various materials were investigated on the basis of their suitability as deuterium-self targets. (auth)

42149 EXCITATION FUNCTIONS OF THE γ-CAPTURE OF PROTONS BY ^{27}Al NUCLEI. Dalmas, Jean; Vidal, Michel; Bertault, Dominique; Lapierre, Alain (Univ., Bordeaux). Compt. Rend., Ser. B; 274: No. 8, 566-9(21 Feb 1972). (In French).

The excitation function of the $^{27}Al(p,\gamma)^{28}Si$ reaction was studied in the E_p = 2.15 to 3.57 MeV range. In this energy range, 35 resonances were identified, a doublet being established at E_p = 2203 keV. (France)

42150 PHOTONEUTRON FROM ^{29}Si AT PHOTON ENERGIES UP TO 13 MeV. Fukuda, Kyue; Okabe, Shigeru. Annu. Rep. Radiat. Center Osaka Prefect.; 12: 41-4(1971).

The photoneutron yield of ^{29}Si was measured as a function of the maximum bremsstrahlung energy up to 13.5 MeV. The cross section for the $^{29}Si(\gamma,n)^{28}Si$ reaction was obtained by using the inverted matrix method of Penfold and Leiss. The cross section curve shows peaks at about 10.6 and 12.2 MeV. The integrated cross section from the threshold to 13.0 MeV is 11 MeV · mb. The angular distributions of photoneutrons were measured for the incident bremsstrahlung with maximum energies of 11.7 and 12.9 MeV. The distributions are fitted with a curve of the form $a + b \sin^2 \theta$, where electric dipole photon absorptions are assumed. The angular distribution coefficients, b/a, are found to be 2.1 ± 1.0 and 3.9 ± 0.8 for bremsstrahlung spectra with maximum energies of 11.7 and 12.9 MeV, respectively. The significant features of the cross-section curve and the angular distributions of neutrons are discussed and compared with the theoretical ones. (auth)

42151 NUCLEAR LIFETIMES OF STATES IN ^{22}Na, ^{22}Ne, AND ^{30}P BY THE RECOIL-DISTANCE METHOD. Snyder, Franklin D. (Univ. of Iowa, Iowa City). Phys. Rev., C; 6: No. 1, 204-11(Jul 1972).

The recoil-distance method was used to measure electromagnetic transition probabilities in ^{22}Na, ^{22}Ne, and ^{30}P. ^{22}Na and ^{22}Ne were produced from the 6.4-MeV ^{4}He-on-^{19}F reaction. ^{30}P was produced from the 6.4-MeV ^{4}He-on-^{27}Al reaction. The mean lives in psec were: $^{22}\mathrm{Ne}_{1.275\to 0}$, 5.9 ± 1.1; $^{22}\mathrm{Na}_{0.891\to 0}$, 16.1 ± 3.0; $^{22}\mathrm{Na}_{1.528\to 0}$, 4.5 ± 0.8; $^{30}\mathrm{P}_{0.709\to 0}$, 53 ± 10. (auth)

42152 LIFETIME MEASUREMENTS IN ^{37}Ar. Luketina, I. A. (Univ. of Auckland, New Zealand); Brock, J. E.; Poletti, A. R. Phys. Rev., C; 6: No. 1, 196-204(Jul 1972).

The Doppler-shift-attenuation method has been used to investigate the lifetimes of states in ^{37}Ar below 3.603-MeV excitation energy. Energies (in keV) and mean lifetimes (in psec) were determined as follows: 1409.8 ± 0.1 (1.22 ± 0.15); 1611.3 ± 0.1 (>5); 2217.1 ± 0.4 (0.91 ± 0.18); 2490.0 ± 0.4 (1.04 ± 0.19); 2795.5 ± 0.6 (<0.04); 3169.7 ± 0.8 (0.10 ± 0.02); 3184.9 ± 1.0 (0.30 ± 0.06); 3271.6 ± 1.0 (0.06 ± 0.02); 3515.9 ± 1.0 (<0.05); 3525.7 ± 2.0 (0.60 ± 0.30); 3603.0 ± 2.0 (<0.08). (auth)

42153 FIRST T = 2 LEVEL IN ^{32}P. Fortier, S. (Institut de Physique Nucleaire, Orsay, France); Laurent, H.; Maison, J. M.; (and others). Phys. Rev., C; 6: No. 1, 378-80(Jul 1972).

The first $J^{\pi} = 0^{+}$, T = 2 level in ^{32}P has been found at an excitation 5073.4 ± 1.5 keV using the reaction $^{30}\mathrm{Si}(^{3}\mathrm{He},p\gamma)^{32}\mathrm{P}$ at 8.02-MeV incident energy. The angular distribution has been analyzed with the distorted-wave Born-approximation formalism. Using a Ge(Li) detector, the γ-decay scheme of this level has been established. The following branching ratios to the ground state, the 1.149-, and the 2.230-MeV levels are, respectively: (5.3 ± 0.9), (84.0 ± 8.5), and (10.7 ± 1.4)%. This is compared with the decay scheme of its analog state in ^{32}S. (auth)

Nuclear Properties and Reactions, $39 \leq A \leq 58$

Refer also to abstracts 41837, 42128, 42130, 42142, 42144, 42145, 42147, 42148, and 42224.

42154 (EANDC(E)-149(U)) ELASTIC SCATTERING OF NEUTRONS BY ^{40}Ca BETWEEN 1.2 AND 2.83 MeV. Abramson, D.; Arnaud, A.; Bluet, J. C.; Filippi, G.; Lavelaine, C.; Le Rigoleur, C. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). 16 Feb 1971. 37p. (In French). Dep. NTIS (U. S. Sales Only).

Proton-recoil scintillation detectors were used to measure the cross section for neutron elastic scattering by ^{40}Ca at 1.2 to 2.83 MeV. Corrections were made for multiple scattering and self absorption. The results are compared with previous data. (J.W.R.)

42155 (GIPR-65) DOPPLER SHIFT ATTENUATION METHOD FOR DETERMINING NUCLEAR LIFETIMES. Ryfors, Jan (Chalmers Tekniska Hogskola, Goteborg (Sweden). Institutionen for Fysik). Apr 1971. 12p. Dep. NTIS (U. S. Sales Only).

A method for determining nuclear lifetimes from Doppler shift measurements of γ-rays is described. Current slowing down theories are used. Different corrections to the attenuation of ion recoil velocities are discussed.. Lifetimes of a number of bound states in ^{53}Mn have been determined by using the $^{52}\mathrm{Cr}(p,\gamma)^{53}\mathrm{Mn}$ reaction. (auth) (Sweden)

42156 (INP-795) INTERMEDIATE COUPLING APPROACH IN THE UNIFIED MODEL OF THE ^{39}K NUCLEUS. Wiktor, S. (Institute of Nuclear Physics, Krakow (Poland)). Mar 1972. 14p. Dep. NTIS (U. S. Sales Only).

The low-lying levels of the ^{39}K nucleus were examined in the framework of the intermediate coupling model in which the $(d_{3/2})^{-1}$ proton hole is assumed to couple to the 2^{+}, 3^{-} and 5^{-} core states of the doubly magic ^{40}Ca nucleus. Comments concerning the parameters are made. In particular the coupling strength parameters are related to the dynamical deformation parameters obtained in coupled channels analysis of the inelastic scattering processes. (auth)

42157 (JINR-P1-6386) STRIPPING OF DEUTERONS OF 9.38 GeV/c ON PHOTOEMULSION NUCLEI. Adamovich, M. I.; Dalkhazhav, N.; Larionova, V. G.; Tolstov, K. D.; Shabratova, G. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). Apr 1972. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

Stripping with the proton escape was studied in the interaction of 9.4 GeV/c deuterons with photoemulsion nuclei. The differential and total cross sections were measured for stripping on the medium weight photoemulsion nucleus (A = 47). (auth)

42158 (ORO-3624-12) NORTH CAROLINA STATE UNIVERSITY NUCLEAR STRUCTURE RESEARCH AT THE TRIANGLE UNIVERSITIES NUCLEAR LABORATORY. Progress Report, September 1, 1971–August 31, 1972. Seagondollar, L. W.; Waltner, A. W.; Mitchell, G. E.; Tilley, D. R.; Gould, C. R.; Nelson, R. O. (North Carolina State Univ., Raleigh). 23 May 1972. Contract AT(40-1)-3624. 22p. Dep. NTIS.

Research in nuclear physics at Triangle Universities Nuclear Laboratory by North Carolina State University in the period Sept. 1, 1971 through August 31, 1972 is briefly reported. (J.W.R.)

42159 ANGULAR CORRELATION STUDIES IN ^{54}Mn. Hill, R. E. Jr.; Buccino, S. G. (Tulane Univ., New Orleans). Particles Nucl.; 3: No. 5, 237-52(May 1972).

The $^{54}\mathrm{Cr}(p,n\gamma)^{54}\mathrm{Mn}$ reaction was used to investigate the low-lying levels in ^{54}Mn. Targets of ^{54}Cr (94%) were bombarded with protons of energies between 2.1 and 3.2 MeV. The γ-rays were observed with a 32 cm^{3} Ge(Li) detector and a 7.6 cm × 7.6 cm NaI(Tl) detector. Gamma rays of energies (±0.5 keV) 55.1, 156.2, 211.0, 249.9, 351.5, and 406.4 keV are assigned as originating in ^{54}Mn. Threshold behavior for the γ-rays coupled with coincidence measurements confirm the existence of levels at 55.1, 156.2, 367.2, and 406.4 keV. No firm evidence was found for a level at about 834 keV. The level at 367.2 keV had not previously been seen in the $(p,n\gamma)$ reaction. Spin assignments of 3, 2, 4, 5, and 3 for the 0, 55.1, 156.2, 367.2 and 406.4 keV states respectively were deduced from γ-ray angular distributions, γ,γ angular correlations and the measured branching ratios. (auth)

42160 EFFECT OF TWO-STEP PROCESS IN QUASI-INELASTIC SCATTERING. Toyama, Manabu; Onishi, Naoki (Tokyo Inst. of Tech.). Progr. Theor. Phys. (Kyoto); 47: No. 2, 460-9(Feb 1972).

An analysis of experimental data on quasi-inelastic scattering $^{56}\mathrm{Fe}(p,n')^{56}\mathrm{Co}^{*}$, $^{48}\mathrm{Ti}(^{3}\mathrm{He},t')^{48}\mathrm{V}^{*}$ and $^{60}\mathrm{Ni}(^{3}\mathrm{He},t')^{60}\mathrm{Cu}^{*}$ was performed assuming combination of a one- and two-step process leading to the isobaric analog states of the first 2^{+} excited states of the target nuclei. Contributions of two-step processes through collective excitation of either the target or residual nucleus have been taken into account by second order perturbation theory. Coupling potentials were derived from a deformed optical potential containing an isobaric spin dependent part. The deformation parameters, β_0 and β_T for the isospin independent and dependent potentials, respectively, were taken to be adjustable parameters. The results indicate strongly the importance of the two-step processes, especially for (p,n′) reaction. In the case of $^{56}\mathrm{Fe}(p,n')^{56}\mathrm{Co}^{*}$, agreement with experimental data is satisfactory using reasonable values of $\beta_T = \beta_0 = 0.24$. For $(^{3}\mathrm{He},t')$ reaction the contribution of the two-step process is of the same order of magnitude as the one-step process and interferes destructively with the latter. Agreement with the experiment is unsatisfactory for the present choice of β_0 and β_T. (auth)

42161 $(^{16}\mathrm{O},^{15}\mathrm{N})$ REACTIONS ON fp-SHELL TARGET NUCLEI. Morrison, G. C.; Koerner, H. J.; Greenwood, L. R.; Siemssen, R. H. (Argonne National Lab., Ill.). Phys. Rev. Lett.; 28: No. 25, 1662-5(19 Jun 1972).

A systematic investigation of the one-proton transfer reaction $(^{16}\mathrm{O},^{15}\mathrm{N})$ on fp-shell target nuclei has been performed at bombarding energies near and above the Coulomb barrier. Angular distributions are qualitatively explained in terms of semiclassical theories. Peak cross sections show a marked Q dependence due to the importance of angular-momentum matching. The main features of the studied reactions are well reproduced both qualitatively and quantitatively by finite-range distorted-wave Born-approximation calculations. (auth)

42162 QUADRUPOLE VIBRATIONS IN THE NICKEL REGION: STRUCTURE OF ODD-MASS Co ISOTOPES. Gomez, Jose M. G. (Univ., Valencia). Phys. Rev., C; 6: No. 1, 149-64 (Jul 1972).

The odd-mass cobalt nuclei from ^{57}Co to ^{63}Co are described in the framework of the unified model. The vibrational description of even-mass nickel isotopes is discussed and the $1f_{7/2}^{-1}$, $1f_{7/2}^{-2}(0)2p_{3/2}$, $1f_{7/2}^{-2}(0)1f_{5/2}$, and $1f_{7/2}^{-2}(0)2p_{1/2}$ proton configurations are coupled to quadrupole vibrational cores. The spacings among these configurations are determined from stripping reaction data and from an analysis of binding energies, and the collective parameters are determined from experimental data on the Ni cores. Good general agreement of calculated and experimental properties is obtained without free parameters involved. For the best known isotopes, ^{57}Co and ^{59}Co, a one-to-one correspondence of the eight or ten first calculated and experimental states is established. Observed spectroscopic factors in pickup and stripping reactions and electromagnetic properties are qualitatively well reproduced for the low-lying levels in general. For the available data most of the calculated values lie within 50% of the experimental values. On the basis of this agreement some spin and parity assignments are proposed among those compatible with experimental data. The results of other models are also discussed. (auth)

42163 ELECTRON-SCATTERING DETERMINATION OF ISOTOPIC DIFFERENCES IN THE CHARGE DISTRIBUTIONS OF ^{46} ^{48} ^{50}Ti. Heisenberg, J. (Stanford Univ., Calif.); Hofstadter, R.; McCarthy, J. S.; (and others). Phys. Rev., C; 6: No. 1, 381-4 (Jul 1972).

Experimental results are presented on the scattering of 200- and 300-MeV electrons by ^{46}Ti, ^{48}Ti, and ^{50}Ti. These results, and their analysis in terms of charge distributions, complete an earlier investigation of calcium isotopes and ^{48}Ti. Isotopic differences in rms radii, in agreement with other measurements, are very small, but the actual differences in charge shapes as revealed by these experiments are considerable. (auth)

42164 INVESTIGATION OF THE CONTINUOUS ELECTRON SPECTRUM ACCOMPANYING THE ELECTRON CAPTURE DECAY OF ^{55}Fe. Nagy, Jozsef. ATOMKI (At. Kut. Intez.) Kozlem.; 13: No. 3, 101-6(Nov 1971). (In Hungarian).

The results of the preliminary measurements on the continuous electron spectrum emitted in the electron-capture decay of ^{55}Fe are described. The intensity and spectrum shape approximately agree with that predicted by the Inteman theory. (3 figures) (auth)

Nuclear Properties and Reactions, 59 ≤ A ≤ 89

Refer also to abstracts 41837, 42145, 42148, 42160–42162, 42181, and 42231.

42165 SURVEY OF MEASUREMENTS OF NUCLEAR REACTION TIME BY MEANS OF THE BLOCKING EFFECT. Tsukada, Kineo (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 14: No. 5, 222-30(May 1972). (In Japanese).

The measurement of nuclear reaction time by means of the blocking effect has been proved to be a very useful method, and increasing numbers of experiments utilizing this technique are being undertaken. In this paper the principle of this technique is described, as well as results obtained on measurements on the ^{28}Si(p,p′), ^{70}Ge(p,p′) and ^{72}Ge(p,p′) reactions performed at JAERI. A survey is presented on recent work in this field. (auth)

42166 YIELDS OF ^{83,84,86}Rb IN REACTIONS INVOLVING PROTONS, DEUTERONS, AND α PARTICLES. Dmitriev, P. P.; Krasnov, N. N.; Dmitrieva, Z. P. At. Energ. (USSR); 32: No. 5, 426-8(May 1972). (In Russian).

The reactions Br + α, Kr + p, Kr + d, and Kr + α to produce the isotopes ^{83,84,86}Rb were studied. The yields of the three Rb isotopes were measured as functions of the deuteron energy for thick krypton targets from 6 to 30 MeV and, similarly, as functions of proton energy for thick Kr targets from 4 to 30 MeV. The yields of ^{83,84}Rb were determined for α-particle energies of 8 to 44 MeV for thick Br targets. (3 figures, 1 table) (K.S.W.)

42167 PROPERTIES OF NUCLEAR LEVELS AND TRANSITIONS IN ODD COPPER ISOTOPES. III. THE ^{62}Ni(p,γ)^{63}Cu REACTION. Kiuru, A. (Univ. of Helsinki); Holmberg, P.; Vanhanen, L. Commentat. Phys.-Math.; 42: No. 1, 11-15(Mar 1972).

The ^{62}Ni(p,γ)^{63}Cu reaction was investigated at E_p = 1298, 1372, 1413, 1430, and 1507 keV. Branching ratios for capturing states and bound states are reported. At E_p = 1298, 1413 and 1430 keV, angular distribution measurements of gamma rays were performed, yielding $J^\pi = 1/2^\pm$ for the E_p = 1298 and 1430 keV resonance states and $J^\pi = 3/2^{(-)}$ for the E_p = 1413 keV resonance state. For the ^{63}Cu levels at 1411.8 and 1547.0 keV, the values $J^\pi = 5/2^{(-)}$ and $1/2^\pm$, $3/2^{(-)}$ are suggested, respectively. The deduced Q-value for the reaction is 6119.2 ± 1.5 keV. (auth)

42168 COINCIDENCE STUDIES OF THE DECAY OF ^{76}As. Funel, Genevieve (Univ., Nice). Compt. Rend., Ser. B; 274: No. 9, 662-4(28 Feb 1972). (In French).

A level scheme is proposed for ^{76}Se, from the decay of ^{76}As. (France)

42169 DECAY OF ^{71}As. Van Hise, James R. (Tri-State Coll., Angola, Ind. Andrews Univ., Berrien Springs, Mich.); Rainis, Albert E. Phys. Rev., C; 6: No. 1, 164-70(Jul 1972).

The singles γ-ray spectrum of ^{71}As was studied using 20- and 40-cm^3 Ge(Li) detectors. γ–γ coincidence data were taken using 7-mm and 20-cm^3 Ge(Li) detectors in conjunction with a 4096 multichannel analyzer with digital gates. Of the 73 γ rays observed, 43 are placed in a decay scheme with 14 excited states along with log ft values for 12 of these. (auth)

42170 STRUCTURE OF THE ODD-MASS GALLIUM ISOTOPES WITH A PARTICLE–PHONON COUPLING MODEL. Almar, R.; Civitarese, O.; Krmpotic, F.; Navaza, J. (Univ., La Plata). Phys. Rev., C; 6: No. 1, 187-95(Jul 1972).

The structure of the low-lying levels in odd-mass gallium isotopes is investigated within the framework of the semimicroscopic model, assuming three protons coupled to a quadrupole vibrator. A detailed comparison with experiments is performed for ^{69}Ga. (auth)

42171 MEAN LIVES OF ^{85}Sr LEVELS. Bucurescu, D.; Ivascu, M.; Popescu, D.; Semenescu, G. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 17: No. 3, 289-95(1972).

Low-lying levels in ^{85}Sr were populated with the ^{86}Sr(^{3}He,αγ)^{85}Sr reaction at 17 MeV incident energy. Gamma-ray spectra were measured at $\theta_\gamma = 90°$ in coincidence with the alpha particles recorded at $\theta_\alpha = +45°$ and −45°. From these DSA measurements, a better accuracy of the excitation energies of some levels was obtained, and mean lives of 180 ± 110, 165 ± 75, and 300^{+500}_{-150} fs were obtained for the levels at E_x = 0.74, 1.15, and 1.65 MeV, respectively. (3 figures, 1 table) (auth)

Nuclear Properties and Reactions, 90 ≤ A ≤ 149

Refer also to abstracts 40938, 41837, 42005, 42130, 42147, 42148, and 42247.

42172 HYPERFINE STRUCTURE ANOMALIES OF ^{115}Sn, ^{117}Sn, AND ^{119}Sn. Krueger, H.; Lutz, O.; Nolle, A.; Uhl, A. (Univ., Tuebingen, Ger.). Z. Naturforsch.; 27a: No. 1, 173-4(Jan 1972).

The ratios of Larmor frequencies in the NMR signals for the pairs ^{115}Sn – ^{117}Sn and ^{117}Sn – ^{119}Sn were measured. The results were used along with previously determined hyperfine interaction constants to determine the hyperfine structure anomalies for the pairs. No reversal of sign between $^{115}\Delta^{117}$ and $^{117}\Delta^{119}$ was found. (J.W.R.)

42173 NOTE ON THE DECAY OF ^{126}I TO ^{126}Te AND ^{126}Xe. Kaji, H.; Tamaki, Y.; Shiokawa, T. (Tohoku Univ., Sendai). Radiochem. Radioanal. Lett.; 10: No. 3, 161-7(30 May 1972).

The decay characteristics of ^{126}I have been studied with the aid of a Ge(Li) spectrometer. Radioactive samples of ^{126}I were obtained by the (γ,n) reaction on pure iodic acid with 25 MeV bremsstrahlung. The energies and intensities of γ-rays of 388.5, 492.0, 666.2, 753.7, 880.5, 1377.9, 1420.1 and 2044.1 keV have been assigned to the decay of ^{126}I. The half-life of ^{126}I is found to be 13 days and the presence of the 2.6 h half-life reported by Aagaard et al. was not detected. (auth)

42174 NEUTRON-RESONANCE SPIN DETERMINATIONS IN ^{143}Nd AND ^{145}Nd FROM CAPTURE GAMMA-RAY MEASUREMENTS. Stolovy, A.; Namenson, A. I.; Ritter, J. C.; Godlove, T. F.; Smith, G. L. (Naval Research Lab., Washington, D. C.). Phys. Rev., C; 5: No. 6, 2030-40(Jun 1972).

Spin assignments were made for 47 neutron resonances in the target nuclei ^{143}Nd and ^{145}Nd by two independent methods: measurement of coincidences between cascade capture γ rays, and measurement of the ratio of low-energy γ-ray intensities. A new method for analyzing data of this type is introduced which enables one to assign a probability of correctness to each spin measurement. The use of an energy window rather than an integral bias level for the coincidence experiment improves the separation of the two spin groups. The s-wave strength function does not appear to be spin-dependent. The distribution of the spin values is consistent with a 2J + 1 level-density dependence. (7 figures, 6 tables) (auth)

42175 ENERGY LEVEL OF ^{126}Te. Miki, Ryota; Kondo, Yasuhide; Sato, Yuji; Azuma, Toshio. Annu. Rep. Radiat. Center Osaka Prefect.; 12: 36-8(1971).

^{126}I was produced by the (γ,n) reaction using an electron linac. The nuclear energy levels of ^{126}Te were studied by Ge–Ge fast-slow coincidence. In the coincidence spectrum of 754 keV gated gamma-rays, two gamma-rays of 435 and 470 keV are detected and the weak nuclear levels were estimated. (auth)

42176 ENERGY LEVEL OF ^{106}Pd. Azuma, Toshio; Sato, Yuji. Annu. Rep. Radiat. Center Osaka Prefect.; 12: 28-35 (1971).

The energy levels of ^{106}Pd are studied by fast-slow coincidence circuit using NaI–Ge and Ge–Ge for ^{106m}Ag and ^{106}Rh. For ^{106}Rh, the angular correlation of 662-keV gated gamma-rays are observed. 662-512, 875 are 0-2-0 and 4-0-2, respectively. For ^{106m}Ag, the angular correlation of 1045-keV gated gamma-rays are observed. 1045-512, 748, 793, 807, and 1200 are 3-2-0, 4-3-2, 2-3-2, and 4-3-2, respectively. The coincidence spectra using Ge–Ge were studied. (auth)

42177 DEPENDENCE OF THE EFFECTIVE CUTOFF ENERGY OF CADMIUM ON NEUTRON TEMPERATURE. Bogomolov, V. N. At. Energ. (USSR); 32: No. 5, 415-16(May 1972). (In Russian).

Cadmium energy depends on the thickness of the Cd sample, the energy and angular distribution of neutrons in the region $E > 0.3$ eV, and the absorption cross section in this range. A relationship was written for the energy distribution of the neutron flux in a moderating medium of sufficiently large dimensions and of small absorption. A noticeable influence of neutron temperature on E_{Cd} was evident, and this value decreased with an increase in neutron temperature. (1 figure) (K.S.W.)

42178 NUCLEAR DATA SHEETS FOR A = 123. Auble, R. L. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 7: No. 4, 363–94(Apr 1972).

Nuclear structure data for the A = 123 isobars are tabulated, and adopted level properties and decay schemes are presented. The information is presented in the following order: level schemes and ladder diagrams for all nuclei in the mass chain showing essentially all adopted level properties, followed by tabulated data, adopted level properties, and adopted gamma-ray properties, where available, for each isobar. All data available through January 1972 are included in the compilation. Additional results for ^{123}Te which were recently received have been added in proof but were not included in the adopted level properties for this nucleus. (auth)

42179 NUCLEAR DATA SHEETS FOR A = 92. Kocher, D. C.; Horen, D. J. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 7: No. 4, 299-361(Apr 1972).

The 1960 version of the Nuclear Data Sheets for A = 92 has been revised on the basis of experimental data received prior to March 1, 1972. Information from approximately 150 papers and communications has been included in the present evaluation. Ten nuclei are known for A = 92. Only the presumed ground states and their half-lives have been established for ^{92}Br, ^{92}Kr, and ^{92}Ru. Extensive investigations of the ^{92}Kr, ^{92}Rb, and ^{92}Sr decay schemes have been reported, but few spin-parity assignments can be made for levels in the daughter nuclei. The stable nuclei ^{92}Zr and ^{92}Mo have been studied via β-decay, γ-decay, transfer reactions, and inelastic scattering; an appreciable number of spin assignments for low-lying levels are firm. Levels in ^{92}Nb up to 0.5 MeV in excitation are well established by transfer reaction and γ-decay studies; however, only tentative spin assignments can be made, many of which are based on shell-model arguments. An analysis of a preliminary ^{92}Tc decay scheme has resulted in a tentative $J^{\pi} = (7^{+})$ assignment for the ^{92}Tc ground state, a value not previously suggested in the literature. Reaction, γ-decay, and ^{92}Ru decay studies have established some excited levels in ^{92}Tc, but no spins are known. Several important gaps and uncertainties remain in the data. The normalizations for transition intensities in the ^{92}Kr and ^{92}Rb decay schemes determined by an indirect method result in unexpectedly low log ft values for the ground-state β-branches. Reaction studies are needed to resolve the ambiguity in the placement of low-lying levels in ^{92}Y from ^{92}Sr decay. Above 2.4 MeV in excitation in ^{92}Zr, the correspondence between levels observed in ^{92}Y decay, transfer reactions, and inelastic scattering is not well determined, resulting primarily from the lack of precise energy determinations in reaction studies. An accurate determination of the half-life of the ^{92}Nb ground state and a careful search for the γ-decay of the first-excited state might establish the spin of the ground state independently of shell-model arguments. Firm spin assignments for the lowest-lying 6^{+} and 8^{+} levels in ^{92}Mo and a confirmation of the proposed ^{92}Tc decay scheme are required for a firm spin assignment for the ^{92}Tc ground state. The placement of levels in ^{92}Tc observed in γ- and β-decay is uncertain. (auth)

42180 EXCITED STATES IN ^{97}Tc FROM THE REACTION ^{97}Mo(p,nγ)^{97}Tc. Picone, J. Michael; Coker, W. Rory; Fitch, Jeff F.; Moore, C. Fred (Univ. of Texas, Austin). Phys. Rev., C; 6: No. 1, 170-8(Jul 1972).

In-beam γ-ray measurements of the excited states in ^{97}Tc have been made using the reaction ^{97}Mo(p,nγ)^{97}Tc at incident proton energies between 3.0 and 6.0 MeV. Singles and γ–γ coincidence measurements were made using Ge(Li) detectors and an on-line two-parameter data-acquisition system. By these methods about 50 γ rays associated with the deexcitation of levels in ^{97}Tc have been observed. Coincidence spectra produced by gates on 11 of the stronger transitions were used along with the singles measurements to identify 28 levels with energies up to 1580 keV excitation. The states at 807, 896, 1127, 1141, 1173, 1220, and 1311 keV have not been previously reported. Evidence is given for states at 833, 850, 1240, and 1410 keV, of which the 850-keV level is isomeric. Branching ratios are given along with a decay scheme for ^{97}Tc. (auth)

42181 COMPARISON OF GAMMA-RAY MULTIPLICITY FOR COMPOUND-NUCLEUS AND DIRECT-REACTION MECHANISMS. Degnan, J. H.; Cohen, B. L.; Rao, G. R.; Chan, K. C. (Univ. of Pittsburgh). Phys. Rev., C; 6: No. 1, 248-50(Jul 1972).

This paper reports an experimental comparison of γ-ray multiplicity (the average number of γ rays emitted in the decay of residual nuclei left by nuclear reactions) for compound-nucleus and direct-reaction mechanisms. The γ-ray multiplicity was determined for (p,p′) reactions with targets ^{122}Sn, ^{116}Cd, ^{64}Ni [for which (p,p′) reactions are direct] and ^{112}Sn, ^{106}Cd, ^{60}Ni [for which (p,p′) reactions are to a considerable extent compound nucleus]. Two bombarding energies, 17 and 12 MeV, were used. The γ-ray multiplicity was found to be approximately the same for compound-nucleus and direct reactions for similar targets, although there is some indication that it is slightly larger for the former in Sn and Cd at 12-MeV bombarding energy, but not at 17-MeV bombarding energy and not for Ni at either bombarding energy. The observed compound-nucleus–direct-reaction differences do not explain why the γ-ray multiplicity is larger for Ni(p,p′) than for Sn(p,p′) reactions. (auth)

42182 LIFETIME OF THE 1314-keV LEVEL IN ^{144}Nd. Li-Scholz, Angela (Rensselaer Polytechnic Inst., Troy, N. Y.); Bakhru, H. Phys. Rev., C; 6: No. 1, 353-7(Jul 1972).

The lifetime of the 1314-keV 4+ level in ^{144}Nd was measured by delayed coincidence using a self-comparison method. The decay of ^{144}Pm to ^{144}Nd proceeds mainly via a 476-keV (4+)–618-keV (2+)–696-keV (0+) γ-ray triple cascade. By means of suitable triple-coincidence requirements, the time spectra of delayed coincidences through the 4+ and the 2+ states were obtained simultaneously but stored separately. These spectra were analyzed for their relative centroid shift, which when combined with the known lifetime of the 696-keV level, yielded a half-life for the 1314-keV level of 20.5 ± 3.7 psec. (auth)

42183 MEASUREMENT OF THE MAGNETIC MOMENT OF THE 57.6-keV STATE OF ^{127}I BY THE MOESSBAUER EFFECT IN FeI. Wolmarans, N. S.; de Waard, H. (Rijksuniversiteit, Groningen, Netherlands). Phys. Rev., C; 6: No. 1, 228-31(Jul 1972).

Using an implanted source of ^{127m}Te in iron in a Moessbauer experiment, the magnetic moment of the 57.6-keV state in ^{127}I is measured to be $(2.54 \pm 0.05)\mu_N$ and the hyperfine field of iodine in iron 1.172 ± 0.016 MG at 4.2°K. The measured magnetic moment continues the regular trend of the magnetic moments of the $7/2^{+}$ states of other iodine isotopes. Its value is in good agreement with the calculations of Kisslinger and Sorensen and of Castel. (auth)

42184 POLARIZATION EFFECTS IN THE ISOSPIN-COUPLED REACTION CHANNELS p + ^{91}Zr AND n + ^{91}Nb$^{*}_{IAS}$. Cramer, J. G. (Univ. of Washington, Seattle); Preikschat, E.; Baker, M. P.; (and others). Phys. Rev., C; 6: No. 1, 366-9(Jul 1972).

The analyzing-power and differential cross-section excitation functions for the reaction p + ^{91}Zr have been measured at 150° in the energy range from 10.0 to 14.9 MeV, which spans the thresholds of the (p,n) quasi-elastic and quasi-inelastic reaction channels leading to the production of the analogs in ^{91}Nb of the ^{91}Zr target ground state and $5/2^{+}$ (1.46 MeV) excited state, respectively. A pronounced variation in the analyzing power is observed in the $(\vec{p},d_0)$ exit channel at just the energy regions where charge-exchange coupling is expected to occur due to the opening of the quasi-elastic and quasi-inelastic channels. Somewhat less expected is the change in analyzing power observed in the elastic proton channel in the vicinity of the quasi-elastic and quasi-inelastic thresholds. Sharp resonance structures are observed in the analyzing-power and differential cross-section excitation functions for the $(\vec{p},d_0)$ channel near the quasi-elastic and quasi-inelastic thresholds which are not readily observable in the elastic channel. The analyzing power for the $(\vec{p},n\bar{p})$ process has been measured at a number of energies in this region and found to be consistent with zero. (auth)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstract 41836.

42185 (AE–264) DECAY OF THE 16.3 min ^{182}Ta ISOMER. Hoejeberg, Mats; Malmskog, Sven G. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Jan 1967. 13p. Dep. NTIS (U. S. Sales Only).

Some transitions in the decay of the 16.3 min ^{182}Ta isomer have been studied with a Ge(Li) detector and a double lens electron coincidence spectrometer. Gamma ray and conversion electron intensities were measured. From a delayed coincidence experiment it was concluded that both of the two lowest excited states in ^{182}Ta had a half-life less than 30 psec. (auth)

42186 (INS–J–134) IN-BEAM GAMMA-RAY STUDY ON $^{188\ 190\ 192}$Pt. Yoshikawa, N.; Ishihara, M.; Kawakami, H.; Kusakari, H.; Sakai, M.; Ishii, K. (Tokyo Univ. (Japan). Inst. for Nuclear Study). 10 Apr 1972. 18p. Dep. NTIS (U. S. Sales Only).

The excited levels of ^{188,190,192}Pt have been investigated by means of in-beam gamma-ray spectroscopy using the (p, 2n) and (p, 4n) reactions. It was observed that the second 2^+ and first 3^+ states were excited with fairly large intensities and the excitation functions of gamma rays differ considerably between the ground-state bands and the side bands. The anisotropies of gamma rays were also measured to determine the mixing ratios of the transitions from second 2^+ states (2_2^+) to first 2^+ states (2_1^+). The prompt and delayed spectra revealed that there were no isomeric states in ^{188,190}Pt nuclei with lifetimes longer than several 10 nsec. (auth)

42187 (JINR–P6-6321) NEW ISOTOPES ^{178}Ir, ^{180}Ir, ^{181}Ir. DECAY SCHEME OF ^{182}Ir. Akhmadzhanov, A. I.; Bayar, B.; Broda, R.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). May 1972. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

New isotopes ^{178}Ir, ^{180}Ir, ^{181}Ir have been identified. Their half-lives are equal, respectively: $T_{½}$ = (0.5 + 0.3) min, $T_{½}$ = 1.5 ± 0.1 min, $T_{½}$ = 5.0 ± 0.3 min. Gamma and γ–γ coincidence spectra for ^{182}Ir have been measured. The decay scheme of ^{182}Ir is given for the first time. (auth)

42188 (JINR–P7-6415) LIFETIMES OF ROTATIONAL STATES OF ^{164}Yb MEASURED BY RECOIL-DISTANCE DOPPLER-SHIFT METHOD. Bochev, B.; Karamyan, S. A.; Kutsarova, T.; Ukhrin, Ya.; Nadzhakov, E.; Venkova, Ts.; Kalpakchieva, R. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). May 1972. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

The lifetimes of ground-band rotational states in ^{164}Yb, produced in the reaction ^{128}Te(^{40}Ar,4n), have been measured by the recoil-distance Doppler-shift method. The obtained B (E2; 1 → 1 – 2) values are compared with those of a rigid-rotor model. (auth)

42189 LEVEL STRUCTURE OF ^{155}Gd. Kanestroem, I.; Loevhoeiden, G. (Univ. of Oslo). Phys. Norv.; 5: No. 2, 111-22 (1971).

A calculation including Coriolis and ΔN = 2 couplings of the low-lying Nilsson orbitals in ^{155}Gd is performed. The energies of the bandheads are based on the Nilsson model. A comparison between the calculated and experimental energies, the (d,p) stripping, and (d,t) pick-up cross sections are used as a guide in analyzing the spectra. Several magnetic dipole and electric quadrupole moments, B(E2)-values, and branching ratios are well reproduced. (auth) (Norway)

42190 STRIPPING AND PICK-UP CROSS SECTIONS FOR ^{157}Gd AND ^{159}Gd CALCULATED FROM THE UNIFIED MODEL. Kanestroem, I.; Tjoem, P. O. (Univ. of Oslo). Phys. Norv; 4: No. 3-4, 181-9(1970).

The negative parity levels in ^{157}Gd and ^{159}Gd are described in terms of the Unified Model. A rotation-particle (Coriolis) coupling is introduced and the band head energies, the decoupling parameters and the moments of inertia for the different bands are determined by fitting the energies. The wave functions thus obtained are used to calculate the (d,p) stripping and (d,t) pick-up cross sections. For ^{157}Gd also some B(E2) values are calculated, and the results are in agreement with the experimental (d,d′) reaction data. (auth) (Norway)

42191 ROTATIONAL AND VIBRATIONAL STATES IN ^{171}Er. Kanestroem, I. (Univ. of Oslo). Phys. Norv.; 4: No. 3-4, 241-6(1970).

A theoretical analysis of the energy levels of ^{171}Er to excitation energies of about 2.5 MeV has been performed. A large number of previously observed states have been assigned as specific Nilsson orbitals and their superimposed rotational bands. The energies, decoupling parameter and (d,p) cross sections suggest complete mixing between a γ-vibrational state and the $½^-$ [510] orbital. In ^{171}Er both the components of the $½^-$ [510] states have been identified. (auth) (Norway)

42192 OBSERVATION OF A SHADOW IN THE ANGULAR DISTRIBUTION OF FRAGMENTS FROM TANTALUM PHOTOFISSION AND AN ESTIMATION OF THE TIME OF FISSION. Skakun, N. A.; Dikii, N. P. (Physical-Technical Inst., Moscow). Yadern. Fiz.; 15: No. 3, 615-16(Mar 1972). (In Russian).

Measurements were made of the photofission time of Ta employing the method of observing the shadow in the angular distribution of nuclear reaction products. Monocrystals of Ta were irradiated with up to 1450 MeV γ quanta, and the tracks left in sheets of mica as a result of different angles of the crystal to the beam were studied. A fission time of 3.3×10^{-17} sec was obtained with the help of the formula of J. Lindhard (1965). (K.S.W.)

42193 DECAY OF ^{164m}Ho AND ^{164g}Ho TO ^{164}Dy AND ^{164}Er. Kaji, H.; Tamaki, Y.; Shiokawa, T. (Tohoku Univ., Sendai). Radiochem. Radioanal. Lett.; 10: No. 3, 151-9(30 May 1972).

The decay characteristics of ^{164m}Ho and ^{164g}Ho have been studied with the aid of a Ge(Li) spectrometer. Radioactive samples of ^{164m}Ho and ^{164g}Ho were obtained by the (γ,n) reaction of spectroscopically pure holmium oxide with 25 MeV bremsstrahlung. The γ-rays of 37.6 and 56.2 keV have been assigned to the decay of ^{164m}Ho, whereas 73.2 and 91.2 keV are attributed to the decay of ^{164g}Ho. The half-lives of ^{164m}Ho and ^{164g}Ho are 37.3 ± 0.5 and 29.0 ± 0.5 min, respectively. From the analysis of x-ray intensities, the branching ratio for the electron capture decay of ^{164g}Ho to the levels in ^{164}Dy has been estimated to be 47%. (auth)

42194 NEUTRON RESONANCE SPECTROSCOPY. IX. THE SEPARATED ISOTOPES OF SAMARIUM AND EUROPIUM. Rahn, F.; Camarda, H. S.; Hacken, G.; (and others) (Columbia Univ, New York). Phys. Rev., C; 6: No. 1, 251-66(Jul 1972).

Neutron transmission and self-indication measurements have been made for two of the separated isotopes of Sm (A = 152 and 154) and the separated isotopes of Eu (A = 151 and 153) at the Nevis synchrocyclotron. The measurements used a 200-m path for transmission measurements and a 40-m path for self-indication measurements, covering an energy range from approximately 1 eV to greater than 5 keV. Since these isotopes are at a region of a peak in the l = 0 strength function, mainly s resonances are involved. The results for the even-even Sm isotopes show that essentially complete s populations were obtained for the first 70 levels in ^{152}Sm and 27 levels in ^{154}Sm. Values of Γ_n (or $g\Gamma_n$ for Eu) were obtained for the observed resonances. Values of Γ_γ, obtained for 9, 3, 45, and 46 levels of ^{152}Sm, ^{154}Sm, ^{151}Eu, and ^{153}Eu, respectively, give $\langle\Gamma_\gamma\rangle$ values of 65, 79, 90.0, and 94.8 MeV, respectively, with most of the individual values within 20% of $\langle\Gamma_\gamma\rangle$. The s strength function is 10^4S_0 = 2.2 ± 0.4, 1.8 ± 0.5, 3.2 ± 0.5, and 2.3 ± 0.4 for ^{152}Sm(n = 90), ^{154}Sm(n = 33), ^{151}Eu (n = 63), and ^{153}Eu(n = 68), where n is the number of levels in the sample. Somewhat smaller S_0 values result for the Sm isotopes if a larger energy interval is used. Values of the mean s level spacing for these isotopes of 51.8 ± 1.5, 115 ± 8, ~0.7, and ~1.1 eV, respectively, were found. Good fits are obtained with the Porter–Thomas theory for the reduced-neutron-width distributions and the Wigner formula for the nearest-neighbor level separation. Other statistical tests applied to ^{152}Sm and ^{154}Sm, respectively, are: (a) the Dyson–Mehta Δ statistic, which is particularly sensitive to long-range order in the level spacings, $\Delta = 0.40$ and 0.38 versus $\Delta_{DM} = 0.42 \pm 0.11$ and 0.32 ± 0.11; (b) correlation coefficients of adjacent nearest-neighbor spacings are −0.26 ± 0.10 and −0.32 ± 0.18 versus −0.27 predicted for an orthogonal ensemble. (auth)

42195 (p,t) POPULATION OF 0^+ STATE IN $^{158\ 160\ 162}$Dy AND $^{164\ 166}$Er. Maher, J. V.; Kolata, J. J.; Miller, R. W. (Univ. of Pittsburgh). Phys. Rev., C; 6: No. 1, 358-65(Jul 1972).

The (p,t) reaction has been studied on targets of ^{160,162,164}Dy and ^{166,168}Er at a proton energy of 17.5 MeV. Excited 0^+ states have been strongly populated in ^{158}Dy (E_x = 0.991 MeV, $\sigma = 0.09\sigma_{g.s.}$), ^{160}Dy ($E_x$ = 1.275 MeV, $\sigma = 0.16\sigma_{g.s.}$), ^{162}Dy ($E_x$ = 1.670 MeV, $\sigma = 0.13\sigma_{g.s.}$), and ^{164}Er ($E_x$ = 1.248 MeV, $\sigma = 0.07\sigma_{g.s.}$). Excited 0^+ states in ^{166}Er are much more weakly populated (E_x = 1.460 and 2.187 MeV, $\sigma = 0.02\sigma_{g.s.}$). This result, along with similar studies of Gd and Yb nuclei, indicates that an excited 0^+ state retains two-neutron-transfer coherence through the mass region between N = 88 (end of shape-transition region) and N = 96. Residual nuclei with 98 neutrons have not exhibited a strong (p,t) population of an excited 0^+ state. (auth)

42196 SEARCH FOR PENETRATION EFFECTS IN THE INTERNAL CONVERSION OF TRANSITIONS IN ^{169}Tm AND ^{171}Tm. Anihotry, A. P. (Tata Inst. of Fundamental Research, Bombay); Gopinathan, K. P.; Jain, H. C.; Baba, C. V. K. Phys. Rev., C; 6: No. 1, 321-31(Jul 1972).

The K- and L-subshell internal-conversion coefficients of the transitions in ^{169}Tm populated in the decay of ^{169}Yb have been measured using a double-focusing electron spectrometer and a Ge(Li) γ-ray spectrometer, with special reference to the retarded transitions, in order to look for any nuclear-structure effects. The particle parameters of the K conversion electrons of the 198.0-, 177.2-, and 130.5-keV transitions in ^{169}Tm and the 308.2- and 295.6-keV transitions in ^{171}Tm have been determined from $e^{-}-\gamma$ and $\gamma-\gamma$ angular-correlation measurements using a single-gap electron spectrometer and NaI(Tl) and Ge(Li) γ spectrometers. A value of the penetration parameter $\lambda = 6-9$ for the 198.0-keV transition in ^{169}Tm has been deduced from the conversion coefficients and the particle parameter. The upper limit of the penetration parameter for the 177.2-keV transition is $\lambda \leq 7$ from the present measurements. The conversion coefficients and particle parameters of the other transitions in ^{169}Tm and ^{171}Tm measured in the present work agree within experimental errors with the theoretical values with no penetration effect. The M3 transition from the 316.2-keV level to the ground state in ^{169}Tm has been found to be retarded by a factor of 90 ± 25 with respect to the single-particle estimate. (auth)

42197 ALPHA-DECAY PROPERTIES OF THE NEW OSMIUM ISOTOPES, ^{170}Os AND ^{171}Os. Toth, K. S. (Oak Ridge National Lab., Tenn.); Hahn, R. L.; Ijaz, M. A.; Walker, R. F. Jr. Phys. Rev., C; 5: No. 6, 2060-4(Jun 1972).

Borggreen and Hyde recently reported the discovery of three new α-emitting osmium isotopes, ^{172}Os, ^{173}Os, and ^{174}Os. The present study deals with a search for osmium nuclides with $A < 172$. These osmium isotopes were produced by bombarding ^{156}Dy with the 160-MeV $^{20}\mathrm{Ne}^{6+}$ beam from the Oak Ridge Isochronous Cyclotron. With the use of α spectroscopy and the helium gas-jet technique, two new α groups were observed. Their mass assignments and decay characteristics are as follows: ^{170}Os, $E_{\alpha} = 5.40 \pm 0.01$ MeV, $T_{1/2} = 7.1 \pm 0.5$ s; and ^{171}Os, $E_{\alpha} = 5.24 \pm 0.01$ MeV, $T_{1/2} = 8.2 \pm 0.8$ s. (3 figures 3 tables) (auth)

Nuclear Properties and Reactions, $190 \leq A \leq 219$

Refer also to abstracts 41836, 42121, 42130, 42145, 42147, 42186, 42224, and 42231.

42198 NUCLEAR DATA SHEETS FOR A = 196. Schmorak, M. R. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 7: No. 4, 395-418(Apr 1972).

The available experimental data pertaining to the nuclear structure of nuclei with A = 196 are compiled; the results from various decay and reaction measurements are compared and evaluated. Inconsistencies and discrepancies in the level schemes are discussed. Level properties, gamma-ray properties, and comments are presented following the data on the relevant nucleus. (auth)

42199 LEVEL DENSITIES NEAR A = 200. Grimes, S. M.; Anderson, J. D.; McClure, J. W.; Pohl, B. A.; Wong, C. (Univ. of California, Livermore). Phys. Rev., C; 6: No. 1, 236-48 (Jul 1972).

Neutron spectra from the reactions ^{197}Au(p,n)^{197}Hg, ^{209}Bi(p,n)^{209}Po, ^{181}Ta(α,n)^{184}Re, and ^{197}Au(α,n)^{200}Tl have been analyzed to extract the level-density parameters for the appropriate residual nuclei. Comparisons with constant-temperature and Fermi-gas forms indicate that both forms describe the data over a limited energy range. A recent calculation of the magnitude of shell effects by Gadioli et al., is compared with the experimentally determined values; this approach provides a better estimate of the level density of ^{209}Po than does the standard Fermi-gas model in which shell effects are included in the level-density parameter a. (auth)

42200 ISOMERIC CROSS-SECTION RATIOS IN THE REACTIONS ^{191}Ir(n,2n)^{190}Ir AND ^{197}Au(n,2n)^{196}Au. Zellermayer, D. Maor; Rosner, B. (Technion-Israel Inst. of Tech., Haifa). Phys. Rev., C; 6: No. 1, 315-20(Jul 1972).

Ratios of total cross sections for the (n,2n) reactions with 14-MeV neutrons leading to the $J^{\pi} = 4^{+}$, 7^{+}, and 11^{-} metastable states in ^{190}Ir and the $J^{\pi} = 2^{-}$, 5^{+}, and 12^{-} metastable states in ^{196}Au have been determined. The experimental results for ^{190}Ir are in agreement with the prediction of the statistical model of the compound nucleus. However, the cross section for the ^{197}Au (n,2n) reaction leading to the 5^{+} isomer in ^{196}Au is at least an order of magnitude smaller than expected. (auth)

42201 PROTON DECAY OF THE ISOBARIC ANALOGS OF THE GROUND STATES OF ^{206}Pb, ^{207}Pb, ^{208}Pb, AND ^{209}Bi. Crawley, G. M.; Miller, P. S. (Michigan State Univ., East Lansing). Phys. Rev., C; 6: No. 1, 306-14(Jul 1972).

The (p,n$\bar{\text{p}}$) reaction has been measured on the lead isotopes ^{206}Pb, ^{207}Pb, and ^{208}Pb and on ^{209}Bi. Coulomb-energy differences are extracted from the positions of the $\bar{\text{p}}$ peaks. Proton decay widths are also obtained and compared with values from resonance experiments and with a previous value from ^{209}Bi(p,n$\bar{\text{p}}$). (auth)

42202 COMPOUND SPREADING WIDTHS FOR ^{209}Bi ANALOG RESONANCES. Beres, William P.; Voges, David A. (Wayne State Univ., Detroit). Phys. Rev., C; 6: No. 1, 284-305(Jul 1972).

The compound spreading widths (due to the Coulomb interaction) of $9/2^{+}$, $11/2^{+}$, $15/2^{-}$, $1/2^{+}$, $7/2^{+}$, and $3/2^{+}$ analog resonances in ^{209}Bi are calculated within the general framework of the de Toledo Piza–Kerman scheme by relegating the giant isovector monopole contributions to the continuum space. The work emphasizes the structure of the parent states and the coupling is via $[H_{C}, T_{-}]$. The widths are found to be of the order of 20 keV, which is considerably less than the observed experimental total widths of 200–300 keV. A background of (i) configuration states (6 including the antianalog state for each analog resonance) and (ii) complex levels (e.g., 33261 states for $9/2^{+}$) are considered. The one-body Coulomb interaction represented by a uniform sphere of charge is used for (i), while the two-body Coulomb force is expanded in multipoles for (ii). In (i) the dependence on the Coulomb radius and the nuclear spreading width are also studied. For all doorways the relative importance, number, density, strength, and compound-width contributions are investigated in great detail and the results are presented in tables and histograms. In addition to certain states of type (i) the most significant complex states are those based on the ^{208}Pb giant dipole doorway resonance. (auth)

42203 OPTICAL-MODEL ANALYSIS OF PROTON ELASTIC SCATTERING BY ^{208}Pb FROM 8 TO 14 MeV. Mo, T.; Davis, R. H. (Florida State Univ., Tallahassee). Phys. Rev., C; 6: No. 1, 231-6(Jul 1972).

The uniqueness and energy dependence of optical-model parameters which describe the ^{208}Pb(p,p)^{208}Pb scattering reaction have been studied in the bombarding range 8 to 14 MeV. In the analysis of data with a 3% error two discretely ambiguous well depths with mean values of 35 and 55 MeV are found which yield comparably good fits. The imaginary well depth is approximately 4 MeV for both. To select one well depth, a 1% measurement was made at the energy ($E_{p} = 7.6$ MeV) at which the difference between the two computed cross sections at backward angles is maximized, a difference of approximately 3%. These measurements select the 55-MeV well depth consistent with the number of occupied states in ^{208}Pb. The spin-orbit term is undetermined in this study, since the values of the imaginary potential render the analysis insensitive to it. (auth)

42204 g FACTORS OF THE 211- AND 240-keV STATES OF ^{195}Pt. Varga, L.; Demeter, I.; Keszthelyi, L.; Mezey, G.; Szoekefalvi-Nagy, Z. (Central Research Inst. for Physics, Budapest). Phys. Rev., C; 6: No. 1, 388-9(Jul 1972).

The statistical accuracy of earlier results was improved by new measurements on $Fe_{72.5}Pt_{27.5}$ and $Fe_{50}Pt_{50}$ targets. In reevaluating the data, corrections were made for beam bending and beam shift, and new data regarding the decay scheme of ^{195}Pt were taken into account. The g factors of the 211- and 240-keV states of ^{195}Pt were found to be 0.104 ± 0.021 and 0.146 ± 0.019, respectively, in disagreement with current theoretical predictions. The value of the hyperfine magnetic field at Pt nuclei in the $Fe_{72.5}Pt_{27.5}$ alloy is in agreement with static measurements, that for the $Fe_{50}Pt_{50}$ alloy is −870 ± 60 kG. (auth)

Nuclear Properties and Reactions, $A \geq 220$

Refer also to abstracts 42371, 42586, 42628, and 42644.

42205 (MLM-1919) TABLES FOR THE INGROWTH OF DAUGHTER PRODUCTS FROM THE DECAY OF PLUTONIUM ISOTOPES USED IN HEAT SOURCES. Haas, F. X.; Campbell, A. R. (Mound Lab., Miamisburg, Ohio). 12 Jun 1972. Contract AT(33-1)-Gen-53. 39p. Dep. NTIS.

This paper lists in tabular and graphic form the ingrowth of activities, as a function of time, of all of the daughter products formed in the decay of the plutonium isotopes found in heat sources. The data are calculated from published half-life values using the Bateman equation. The paper is intended as a ready reference for the determination of these ingrowth data. (auth)

42206 MEASUREMENT OF THE HALF-LIFE OF ^{241}Am BY ADIABATIC MICROCALORIMETRY. Jove, J.; Robert, R.

(Institut du Radium, Paris). Radiochem. Radioanal. Lett.; 10: No. 3, 139–43(30 May 1972). (In French).

The half-life of ^{241}Am has been determined from a metal sample using the adiabatic microcalorimetric method of Lecoin and Robert. A value of 426.3 ± 2.1 years has been obtained. (auth)

42207 STUDY OF THE γ RADIATION ACCOMPANYING THE DECAY OF ^{234m}Pa. Marsol, Claire; Ardisson, Gerard. (Institut d'Etudes Nucleaires, Algiers). Compt. Rend., Ser. B; 274: No. 6, 429-32(7 Feb 1972). (In French).

The γ ray spectrum of ^{234m}Pa was measured using a large volume Ge(Li) detector capable of distinguishing the low intensity transitions observed in the electron capture decay of ^{234}Np. The ^{234}Pa+ ^{234m}Pa equilibrium mixture forming in the decay of ^{234}Th was used. Comparison of the measured energies and intensities with data on ^{234}Pa leads to the assignment of lines to ^{234m}Pa. (France)

42208 DECELERATION OF ^{235}U FISSION FRAGMENTS IN LIGHT MEDIA. Lutsenko, V. P.; Polyanskii, N. V.; Dobrovol'skii, S. P. At. Energ. (USSR); 32: No. 5, 411-12(May 1972). (In Russian).

Published data on the deceleration of fission fragments were used to test a mathematical expression which had previously been used to describe the slowing down of heavy ions. A modification of the equation was developed which more accurately described the loss of energy of fragments, not only in light, but also in heavy, decelerating media. (1 figure) (K.S.W.)

42209 EFFECT OF EQUIPMENT RESOLUTION IN INVESTIGATIONS OF THE SYMMETRICAL FISSION REGION IN HEAVY NUCLIDES. Zakharova, V. P. This paper was summarized in At. Energ. (USSR); 30: No. 3, 299-300(Mar 1971) as paper No. 471/5852. (In Russian).

Full copy of this paper is held by TIC.

The value of the total kinetic energy of (^{235}U) fragments varies according to data reported by different authors, from 134 MeV to 159 MeV. This uncertainty might be due to a failure to take dispersion corrections fully into account. Recalling the conclusions voiced to the effect that the principal restriction imposed on resolution (emission neutrons) is 1.3 mass unit (mu) for the time-of-flight method and 5.5 mu for the ionization method of determining the masses of fragments, the author cites a tentative estimate made of dispersion effects. Peak-to-valley ratios are computed for real mass distributions under the assumption that the "ideal" mass distribution is given by the methods of radiochemistry, while the resolution function assumes the shape of a gaussian curve. The unknown ratios turned out to be 1/450 and 1/300 at 4 mu and 7 mu resolutions, respectively. Attention is directed to the fact that very pure delineation of the symmetrical region by several authors (1/500^{141}, 1/580^{121}, 1/620^{151}) should be supported by more rigorous experimental proofs. The predicted dispersion "spread" in some data reported which were obtained by the time-of-flight method (2 mu resolution) showed that the energy spectrum of spurious "dispersion" events peaks in the symmetrical region, with an average energy in the vicinity of 170 MeV. The absence of "hard" events in the symmetrical region of energy >150 MeV, recorded by the time-of-flight method, might be connected with the basically poor resolution of that method. Spurious effects associated with the "tail" of the resolution function are also analyzed. It is shown that spurious events will group together in the form of peaks with average energies. (1) $E_R = 68(1 + R)$MeV; (2) $E_R = 68(1 + 1/R)$MeV, for the lengths of the "tail" shorter (1) and larger (2) than ~40 MeV, (for fission of ^{235}U by slow neutrons, with R the mass ratio of the fission fragments.) (auth)

42210 FISSION TO (n,2n) REACTION RATIOS IN FAST REACTORS. Ohta, Masao (Kyushu Univ., Fukuoka); Nishihara, Hiroshi. Kyushu Daigaku Kogaku Shuho; 44: No. 4, 479-85(Aug 1971). (In Japanese).

Ratios of fission to (n,2n) reactions for ^{232}Th and ^{238}U were evaluated to investigate problems encountered in designing fast reactors. The compound-nucleus evaporation model was used. Evaluation of σ for the (n,2n) reaction was performed up to 10 MeV from threshold energy. The cross section σ (n,2n) was expressed as σ (n,n′) Bn, where Bn is the probability of second neutron emission, and was calculated by using the level density of residual nuclei, the energy of incident particles, and the reciprocity theorem. For the high energy region, the formula for the cross section of the (n, 2n) reaction was reduced to the following, $\sigma\,(n,2n) = \pi R^2(1 - X)$ $X = [1 + \Delta En/\Theta\,(En)] \exp [-\Delta En/\Theta\,(En)]$ $\Delta En = En - (\text{Binding Energy})n$ where Θ (En) is nuclear temperature. The neutron spectrum in a fast reactor was simulated with a fission spectrum by the use of Rosen's formula. The fission cross sections of ^{232}Th and ^{238}U and the reaction ratio of fission and (n,2n) reaction are shown. The obtained ratio of fission to (n,2n) reaction were 6 for ^{232}Th and 25 for ^{238}U. (Japan)

42211 ENERGY DEPENDENCE OF $\bar{\nu}$ DURING FAST NEUTRON FISSION OF ^{238}U. Savin, M. V.; Khokhlov, Yu. A.; Paramonova, I. N.; Chirkin, V. A. At. Energ. (USSR); 32: No. 5, 408-10(May 1972). (In Russian).

The energy dependence of $\bar{\nu}$ for ^{238}U was measured by the time-of-flight method with a resolution of 1 ns/m. Measurements were conducted on a linear electron accelerator with a 400-liter liquid scintillator detector. The flight path was 35 m. The experiment was conducted with a cycle of identical measurements with ^{238}U, with a sample of lead, and without a sample. The energy range investigated was approximately 1.5 to 5.5 MeV, and the data are compared with those of other workers. (1 figure, 1 table) (K.S.W.)

42212 NUCLEAR LEVELS IN ^{233}Th EXCITED BY NEUTRON CAPTURE AND (d,p) REACTIONS. von Egidy, T. (Technische Univ., Munich); Schult, O. W. B.; Rabenstein, D.; (and others). Phys. Rev., C; 6: No. 1, 266-84(Jul 1972).

Low-energy γ rays of the reaction ^{232}Th(n,γ)^{233}Th have been measured with the Risö bent-crystal spectrometer and with a Ge(Li) spectrometer at Munich. High-energy neutron-capture γ rays from four low-energy neutron resonances have been investigated at the fast-chopper facility at Brookhaven. Data on the reaction ^{232}Th(d,p)^{233}Th were taken with an Enge split-pole magnetic spectrograph at the tandem Van de Graaff accelerator at Argonne. The combination of these data resulted in a level scheme of ^{233}Th. Seven Nilsson configurations have been assigned to rotational bands, two of them tentatively. Spectroscopic factors have been calculated with ϵ_4 deformation and Coriolis mixing, and compared with the experiment. The neutron binding energy in ^{233}Th has been determined to be 4786.5 ± 2.0 keV. (auth)

42213 PAIRING VIBRATIONS AND ALPHA DECAY. Cioaca, C. (Univ., Bucharest); Cristu, M.; Dumitrescu, O.; Sandulescu, A. Rev. Roum. Phys.; 17: No. 3, 281-8(1972).

It is shown that the first excited $1K\pi = 00+$ states in the actinide region cannot have a simple pairing structure. Strong disagreement in both alpha hindrance factors and energies belonging to these states with experimental data and values from other models is obtained. The earlier hypothesis, that these states should have a more complex structure involving long-range (quadrupole and spin–quadrupole) forces, is verified. Also, it is shown that the alpha transitions to the first pairing–vibrational states in the actinide region, if they exist, are very hindered. (2 figures, 1 table) (auth)

Nuclear Theory

Refer also to abstracts 41842, 41973, 41990, and 42468.

42214 (AAEC/TM–597) COMPOUND NUCLEUS FORMULATION OF REACTION MATRIX THEORY. Cook, J. L.; Bertram, W. K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb 1972. 28p. Dep. NTIS (U. S. Sales Only).

It is shown that multilevel resonance parameters for each element of the reaction matrix cannot be determined from available data. However, additional constraints may be introduced without affecting agreement with experiment. The Bohr compound nucleus hypothesis is applied to the T-matrix and it is found, as in Newton's model, that the channel matrix can be inverted analytically to provide simple formulas for cross sections, for both the real Wigner–Eisenbud reaction matrix and Moldauer's complex reaction matrix. Wigner–Eisenbud theory leads directly to Newton's strong correlation model and its unacceptable consequences. Moldauer's theory does not and cannot explain cross section behavior adequately while being consistent with Bohr's hypothesis. Cross sections can be written as a sum of single level contributions, as in the Adler–Adler formulation. Finally, Moldauer's statistical theory is shown to be applicable, and expressions are derived for the averaged cross sections as functions of the complex Moldauer resonance parameters. (auth)

42215 (AAEC/TM–612) ON THE NONINVARIANCE OF DISTRIBUTIONS OF REACTION MATRIX PARAMETERS UNDER CHANGES IN BOUNDARY CONDITIONS. Bertram, W. K.; Cook, J. L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar 1972. 16p. Dep. NTIS (U. S. Sales Only).

Contrary to current opinion, the statistical distributions of level spacings and reduced widths when applied to the reaction matrix, are not invariant under changes in the boundary condition matrix or the matching radius. General arguments are given, together with specific examples which violate the invariance requirements. It is concluded that it is the parameters of the collision matrix which should be analyzed and considered as the invariant parameters. (auth)

42216 (COO-1120-142) COULOMB FORCES IN THE NUCLEAR 1p-SHELL. Anderson, R. K.; Wilson, M. R.; Goldhammer, Paul (Kansas Univ., Lawrence. Nuclear Structure Lab.). [nd]. Contract AT(11-1)-1120. 54p. Dep. NTIS.

Correlated wave functions obtained by solving the Bethe–Goldstone equation with realistic nuclear interactions are employed to calculate Coulomb shifts, isospin mixing, Coulomb energies, and coefficients of the isobaric mass formula in 1p-shell nuclei. Improved agreement with experiment is obtained, particularly for the Coulomb shifts and isospin mixing which are not sensitive to the size parameter. No evidence is found favoring a charge dependent component in the nuclear force. (auth)

42217 (INR-P-1374) EFFECT OF VARIABLE INERTIAL PARAMETER ON PENETRATION OF THE DOUBLE POTENTIAL BARRIER IN FISSIONING NUCLEI. Dudek, Jerzy (Institute of Nuclear Research, Warsaw (Poland)). 1972. 41p. Dep. NTIS (U. S. Sales Only).

The transparency of the double hump potential barrier is studied by means of the analytical solution of the Schroedinger equation. Different choices of the potential parameters are made and properties of the resulting penetrabilities are compared and discussed. The influence of the variable inertial parameter is examined on the example of the double barrier constructed from square-well potentials with free dependence of the inertial parameter on deformation. The exact calculations are compared with the WKB approximation results. The sensitivity to the variation of the potential parameters is discussed. It is shown that the substitution of a few constants instead of a continuously varying inertial parameter in the Schroedinger equation gives a good approximation when the barrier shape is close to the symmetric one. (auth)

42218 (ITJ-14) NUCLEON–NUCLEON INTERACTION. Jerzy, Jura (Institute of Nuclear Techniques, Krakow (Poland)). Dec 1971. 18p. (In Polish). Dep. NTIS (U. S. Sales Only).

The phase shift approach to the problem of nuclear forces is presented. Its application to nucleon–nucleon scattering is discussed. (auth)

42219 (JINR-P4-6298) REACTION OF QUASIELASTIC KNOCKING-OUT OF DEUTERONS BY HIGH-ENERGY PROTONS AND ATOMIC NUCLEUS STRUCTURE. Kalinkin, B. N.; Shmonin, V. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). Mar 1972. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that detailed information on the structure of the target nucleus is not required when interpreting the available experimental data on the quasielastic knocking-out of deuterons by high-energy protons. For this purpose it is quite sufficient to use general characteristics of a nucleus as: charge, mass, mean radius and the simplest type of the density distribution. Probably the structure peculiarities of nuclei can be revealed in more complete (fixation of all the products, including excitation energy of residual nuclei) and precise experiments. (auth)

42220 (JINR-P4-6299) TO THE PROCESS OF DEUTERON KNOCKING-OUT FROM NUCLEI BY HIGH-ENERGY PROTONS. Kalinkin, B. N.; Shmonin, V. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). Mar 1972. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The model used previously for description of quasielastic knocking-out of deuterons by high-energy protons is tested. With the help of this model the results are interpreted on the yield of deuterons with the momenta in the range of 1200–1500 GeV/c at $E_p = 675$ MeV. The consequences of the model for the process (d,p) and the processes of π^--, k^--meson production are described as well as for the processes of antiproton production on nuclei at high energies in the momentum region near the kinematical limit. (auth)

42221 (LA-4969) ELASTIC PION-NUCLEUS SCATTERING FOR STUDIES OF THE NUCLEAR SURFACE. Kisslinger, L. S.; Burman, R. L.; Koch, J. H.; Sternheim, M. M. (Los Alamos Scientific Lab., N. Mex.). Jun 1972. Contract W-7405-eng-36. 10p. Dep. NTIS.

The use of elastic $\pi^{\pm}$-nucleus scattering to explore the relative neutron-proton distributions in nuclei is studied theoretically. The large difference between π^+-N and π^--N interactions in the nuclear surface leads to substantial effects. Neutron radius determinations to 0.1 Fermis appear feasible. (auth)

42222 (ORNL-TM-3778) GENERAL FORMALISM FOR COMPUTING THE TRANSITION MATRIX OF NUCLEAR REACTION THEORY, AND ITS APPLICATION TO THE TREATMENT OF THE COUPLED CHANNEL EQUATIONS. Perez, R. B. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 54p. Dep. NTIS.

One develops a general integro-differential equation for the transition matrix of nuclear reaction theory in terms of the physical parameters of the nuclear reaction. On this basis, one arrives at a unified formalism which affords a great degree of flexibility regarding the boundary conditions of the basic set of eigenfunctions utilized to construct solutions of the radial Coupled Channel Equations. One also develops, as a corrollary of the main result, a system of equations which describes the motion of the poles and residues of the collision matrix as a function of the parameters entering in the reaction formalism. Various applications are shown to illustrate the present technique. (auth)

42223 SVOISTVA ATOMNYKH YADER. VYPUSK 12. SVOISTVA DEFORMIROVANNYKH YADER $K = 1/2$. (Properties of Atomic Nuclei. Number 12. Properties of Deformed Nuclei with $K = 1/2$). Dzhelepov, B. S.; Dranitsyna, G. F.; Mikhailov, V. M. Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1971). 252p.

Among the deformed atomic nuclei are frequently encountered nuclei whose fundamental or excited state is characterized by a quantum number $K = 1/2$. Special features in the structure of rotational bands then arise, related to the intensity of transitions, large magnetic moments, etc. Experimental data are here systematized which pertain to the nuclei of $150 < A < 230$. A generalized model was used in the theoretical analysis, and the results are presented of a microscopic treatment of the properties of deformed nuclei. (tr-auth)

42224 CONTRIBUTION TO THE PROBLEM ON THE STRUCTURE OF ISOBARIC ANALOG AND CONFIGURATION STATES. Aleshin, V. P.; Kolomiets, V. M. (Inst. of Nuclear Research, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 11, 1868-76(Nov 1971). (In Russian).

A theory of isobaric analog configuration and core-polarization states with a definite total angular momentum is presented based on a shell-model theory. The structure, energy and "mixing" of the isobaric analog and configuration states are investigated. Numerical calculations for the nuclei ^{209}Bi, ^{49}Sc are given. (auth)

42225 DIRECT REACTION THEORY. Vold, P. Bergen, Norway; Univ. of Bergen ([1971]). 91p. (In Norwegian).

Lecture series held at the Dept. of Physics, Univ. of Bergen, Spring Term 1971.

The first of the three chapters deals with the theory of inelastic scattering of particles in a beam by a target. Following a discussion of cross section, wave packets and scattering amplitude, the Born Approximation and the DWBA for elastic scattering are presented. In the second chapter general scattering theory is treated including sections on the optical potential and the DWBA. Finally in chapter three the application of DWBA for (d,p) reactions is given, followed by remarks in connection with antisymmetrization and spectroscopic application of stripping. (J.I.W.)

42226 SPHERICAL MODEL AND THE INFINITE SPIN DIMENSIONALITY LIMIT. Kac, M. (Rockefeller Univ., New York); Thompson, C. J. Phys. Norv.; 5: No. 3-4, 163-8(1971).

An alternative treatment of the spherical model is presented and a proof given of a statement of Stanley's that the spherical model free energy is equal to the corresponding free energy of a system of classical d-dimensional spins, in the limit d. The statement, moreover, is shown to be valid independently of the ordering of the thermodynamic limit and the infinite spin dimensionality limit. (auth) (Norway)

42227 MODIFIED QUASI-PARTICLE MODEL. Bolterauer, H. (Univ., Giessen, Ger.). Z. Naturforsch.; 27a: No. 1, 1-7 (Jan 1972).

By use of the quasiparticle-quasihole space as model space, a model is established in order to determine excitation energies and transition probabilities of atomic nuclei. The equations derived show a remarkable correspondence to those in Migdal's quasiparticle theory. The validity of the quasiparticle hypothesis, which is fundamental in Migdal's theory, is not a necessary condition for a weak dependency of the effective interaction. This energy dependency is also independent of the choice of the one particle basis. (auth)

42228 EIKONAL EXPANSION IN ATOMIC AND NUCLEAR SCATTERING. Wallace, Stephen Joseph. Seattle; Univ. of Washington (1971). 323p. University Microfilms Order No. 72-15,156.

Thesis.

An eikonal expansion of the scattering T matrix is investigated and systematic corrections to the Glauber high-energy approximation in scattering theory are obtained through third order in the inverse momentum. The eikonal expansion for potential scattering is developed consistently through third order and undesirable terms involving the momentum transfer are found to arise in the expansion. For small scattering angles they can be safely neglected and the results can be neatly summarized by an exponential form for the impact parameter representation of the T matrix. A mechanism is discovered in the first few eikonal corrections which cancels leading powers of momentum transfer arising from the undesirable terms. Based on this mechanism it is conjectured that the impact parameter representation of the T matrix for forward scattering may be valid for all momentum transfer. Numerical tests lend support to this conjecture. Calculations show that the theory converges successfully, particularly at forward angles, when the potential is weak and changes little in a distance comparable to the projectile wave length. For very large momentum transfer the convergence appears to be asymptotic however. Relativistic electron scattering is considered using the theory. First the eikonal expansion is shown to be applicable to the dominant part of relativistic T matrix for a Dirac particle in a static electromagnetic potential. Then the full interaction between a relativistic electron and a many particle non-relativistic nucleus is considered. Employing eikonal approximations for both particles plus the sudden approximation for the target nucleus and ignoring magnetic interactions, a formula for the scattering amplitude is derived which is the relativistic analog of the well-known Glauber theory. Finally the eikonal expansion results for a static potential and the nonstatic effects from the relativistic Glauber theory are combined to yield a formula valid for large angle electron scattering by nuclei including the non-static, or dispersive, effects. Dispersion corrections for e-^{40}Ca are calculated using several nuclear models based on this theory. The dispersion corrections to electron scattering are found to be too small for experimental detection except in the diffraction minima of the differential cross section. (Diss. Abstr. Int., B)

42229 NONLOCAL OPTICAL POTENTIAL WITH A FINITE NUMBER OF SEPARABLE TERMS. Suzuki, Takehiko (Shizuoka Univ., Japan). Progr. Theor. Phys. (Kyoto); 47: No. 2, 718-19 (Feb 1972).

Starting with the many-body wave equation for a nuclear system, an attempt is made to derive a tractable nonlocal optical potential with a finite number of separable terms. Nuclear processes are limited to elastic, inelastic, and charge-exchange scattering. Antisymmetrization is omitted for simplicity. The shortcomings of the derived potential are discussed. (J.W.R.)

42230 TWO-PARTICLE ORBITAL DENSITY MATRIX FOR ONE-QUANTA OSCILLATORY-EXCITED STATES OF UNITARY SCHEME FOR p-NUCLEI. Vanagas, V. V.; Kalinauskas, R. K. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys; 11: No. 5, 729-41(1971). (In Russian).

The expressions of coefficients for decomposition of the unitary scheme wave function in terms of the wave functions for SU$_3$-configurations in the case of one-quanta oscillatory-excited states of p-nuclei have been found. The explicit formulas for matrix elements of one- and two-particle density matrices, depending only on the orbital quantum numbers, have been given. (auth)

42231 DETERMINATION OF STRONG INTERACTION NUCLEAR RADII. Egusa, Toshimasa (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 2, 716-18(Feb 1972).

The strong interaction nuclear radius is investigated on the basis of a simple nuclear model. The photoproduction of vector mesons on complex nuclei is related to the photoproduction from single nucleons with subsequent nuclear absorption. Absolute values of the strong interaction radius are predicted for ω photoproduction at 0^0 on ^{9}Be, ^{12}C, ^{27}Al, ^{64}Cu, and ^{208}Pb. The results are compared with other calculations. (J.W.R.)

42232 POTENTIAL FOR DESCRIBING SINGLE-NUCLEON STATES IN FISSION OF ATOMIC NUCLEI. Gamalya, I. A.; Cherdantsev, P. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 7, 23-31(1971). (In Russian).

A potential is proposed for describing single nucleon states both for symmetric and asymmetric nuclear fission. Equipotential surfaces correspond to a general form of nuclei: intersecting spheres and ellipsoids of diverse types, Cassinian ovaloids and more general unsymmetric figures with respect to z. Methods of solving the Schroedinger equation for the portion of potential dependent on Z, and energy levels at this potential were obtained for several deformations. (tr-auth).

42233 K-HARMONIC METHODS FUNDAMENTAL EQUATIONS FOR THE THREE-PARTICLE CLUSTER CONFIGURATIONS. Dzhibuti, R. I.; Krupennikova, N. B.; Mamasakhlisov, V. I.; Tomchinskii, V. Yu. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 66: No. 3, 565-8(Jun 1972). (In Russian).

A method of K-harmonics is developed for the cluster model of nuclei. The fundamental equations determining the wave functions and binding energies of the three-particle configurations of ^{6}Li, ^{9}Be and ^{12}C nuclei are obtained. NN, Nα and $\alpha\alpha$ interaction potentials are parametrized from the free scattering data. (auth)

42234 THEORY OF COLLECTIVE EXCITATIONS IN SPHERICAL ODD-MASS NUCLEI. II. STRUCTURE OF THE ANOMALOUS COUPLING STATES WITH SPIN $I = (j - 1)$. Kuriyama, Atsushi; Marumori, Toshio; Matsuyanagi, Kenichi (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 47: No. 2, 498-522(Feb 1972).

A new point of view on the structure of the anomalous coupling states is proposed. In this point of view, the main component of the anomalous coupling states with spin $I = (j - 1)$ is considered to be the dressed three-quasi-particle mode, which has been developed in a previous paper, part I, as a new collective mode in spherical odd-mass nuclei. The excitation-energy systematics of the anomalous coupling states is theoretically made with the use of the pairing-plus-quadrupole force. From the numerical results, it is concluded that the excited anomalous coupling states with spin $I = (j - 1)$ can be recognized very well as the dressed three-quasi-particle states. The role of the three-quasi-particle correlation in characterizing the anomalous coupling states is investigated, and the importance of the three-quasi-particle correlation in the collective excitations in odd-mass nuclei is demonstrated. (auth)

42235 APPROACH TO THE UNIFIED THEORY OF NUCLEAR REACTIONS. Kitazoe, Yasuhiro; Sekiya, Tamotsu (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 2, 470-83(Feb 1972).

In the unified theory of nuclear reactions, an attempt is made to classify effectively a nuclear reaction into a simple mechanism process and a compound nucleus process. The method of classification is based on the number of target nucleons which interact directly with the incident particle on the way of the reaction. The simple mechanism states include both the scattering states and the doorway states which couple strongly to the open channels. The compound nucleus states are defined independently of the open channels. Different pairs of projection operators are introduced through the following two stages: In the first stage, operators P and Q are introduced in order to decompose the eigenstates of the system into the compound nucleus states and the simple mechanism states. In the second stage, operators p_c and q_c are used in order to approximate the simple mechanism states by the states of the early or last stage of the reaction A(a,b)B. Through the above two stages, the exact transition amplitude for this reaction is rewritten into a form of the unified description. Explicit forms of the projection operators are always given in the case not only of scattering but also of reactions. The method can be applied effectively to kinds of exchange reactions at low energies. (auth)

42236 INTERACTION BETWEEN NUCLEON-CLUSTERS WITH FULL EXCHANGE EFFECTS. AN EQUIVALENT LOCAL POTENTIAL IN A SOLUBLE MODEL. Okai, Sueji; Saito, Sakae; Tamagaki, Ryozo (Niigata Univ., Japan). Progr. Theor. Phys. (Kyoto); 47: No. 2, 484-97(Feb 1972).

In order to shed light on the seeming conflict between the repulsive core of the phenomenological $\alpha-\alpha$ potentials and the almost stationary inner oscillations of the wave functions obtained by the resonating group method, the phase-equivalent local potential preserving the inner oscillations is investigated for an exactly soluble model. In this model, the s-wave relative wave function has the inner oscillation at short distances due to the orthogonality condition to one forbidden state which embodies an essential role of the Pauli principle. Based on the model calculation, it is concluded that the equivalent local potential accompanying considerable energy dependence is mainly attractive at positive energy but loses physical meaning at negative energy because of the absence of bound states. A strong repulsive core with a large radius as found in the phenomenological analysis has no literal meaning, and should be regarded as an aspect of a model interaction without energy dependence that implies the non-existence of bound states located inside despite of the existence of the inner radial nodes. (auth)

42237 REACTION MATRIX APPROACH TO THE INVERSE PROBLEM. Cook, J. L. (Australian Atomic Energy Commission Research Establishment, Sutherland). Aust. J. Phys.; 25: No. 2, 167-76(Apr 1972).

The problem of inverting the calculation of cross sections to one of determining interaction potentials from cross sections is dealt with using the reaction matrix approach. The experimentally obtained resonance parameters are utilized to calculate constants which are coefficients of expansion of the potential in terms of known functions. (auth) (Australia)

42238 APPROXIMATION METHOD BASED ON IDENTITIES FOR CALCULATING NUCLEAR MATRIX ELEMENTS. I. GENERAL PROCEDURE. Fujita, Jun-ichi (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 47: No. 2, 523-34(Feb 1972).

The approximation method using projection operators, which was previously proposed and applied to calculations of hindered beta matrix elements, is reexamined from a more general viewpoint and extended to a method suitable to include both backward and forward correlations. The present method is compared with the previous methods, especially the RPA in the pairing model. New formulas are applicable not only to the hindered matrix elements but also to unhindered matrix elements. The merit of the present method is that the coherent effect of small admixtures in wave functions is expressed as sum rules, which can also be regarded as semi-phenomenological parameters, and the way to estimate neglected terms is clearly seen because the method is based on identities. (auth)

42239 THEORY OF ALLOWED BETA DECAY WITH HIGHER ORDER CORRECTIONS. Morita, Masato (Osaka Univ.); Fuyuki, Masahiko; Tsukada, Shinobu. Progr. Theor. Phys. (Kyoto); 47: No. 2, 556-71(Feb 1972).

Formulas for the ft value, beta-ray spectrum, beta-ray angular distribution and beta-gamma directional as well as circular polarization correlation are given in the case of parity-nonconserving allowed beta transitions. Contributions of all improper second forbidden matrix elements, $\int r^2$, $\int \alpha \cdot r$, $\int \sigma r^2$, $\int (\sigma \cdot r) r$, $\int \gamma_5 r$ and $\int \alpha \times r$, are taken into account up to their square terms. The correction due to the finite size of the daughter nucleus and the finite de Broglie wavelength effect can be included by evaluating the combinations of the electron wave functions, f_k and g_k, and their phases, numerically. (auth)

42240 INDUCED-TENSOR INTERACTION IN WEAK PROCESSES. Eman, B. (Rudjer Boskovic Inst., Zagreb. Univ., Zagreb); Tadic, D.; Krmpotic, F.; Szybisz, L. Phys. Rev., C; 6: No. 1, 1-12(Jul 1972).

The nonrelativistic impulse approximation for the induced-tensor interaction has been analyzed in detail. ft values for mirror transitions have been calculated using electron Coulomb wave functions for the extended charge distribution and introducing higher-order corrections. Fourteen angular $\beta-\gamma$ correlations, the β transition being allowed, have been analyzed, showing that this process is sensitive to the presence of the induced-tensor interaction. The amount of information about the induced tensor at present obtainable from circular γ polarization in nuclear transitions has been investigated. A limit on the induced-tensor coupling constant has been obtained which does not contradict the evidence based on ft values. $\beta-\gamma$ angular correlations seem to yield evidence for the weak-magnetism term, while not excluding the existence of the induced tensor. (auth)

42241 RESCATTERING EFFECTS AND THE VALIDITY OF THE SEQUENTIAL-DECAY MODEL. Friedman, William A. (Univ. of Wisconsin, Madison). Phys. Rev., C; 6: No. 1, 87-95 (Jul 1972).

A steady-state point of view is used to examine the conditions under which rescattering corrections to the sequential-decay model are important in considering direct reactions to unbound states. Expressions are derived which can give semiquantitative estimates of the size of these effects. A qualitative interpretation is provided for the factors which enter these expressions, and they are evaluated for two specific cases, one where the rescattering effects are expected to be large, and one where they are expected to be small. (auth)

42242 FADDEEV EQUATIONS FOR REALISTIC THREE-NUCLEON SYSTEMS. II. BOUND-STATE WAVE FUNCTIONS. Harper, E. P.; Kim, Y. E.; Tubis, A. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C; 6: No. 1, 126-36(Jul 1972).

Starting from previous work on the complete angular momentum reduction of the Faddeev equations, general formulas are developed for constructing the bound-state wave function from the Faddeev amplitudes. The L–S coupling scheme is used. For trinucleon systems with nucleon-nucleon interactions in the $^1S_0$ and $^3S_1-^3D_1$ states, the complete set of homogeneous Faddeev equations and the formulas for constructing the wave functions are given in detail. The wave function is also given in terms of the Derrick–Blatt classification of states. (auth)

42243 COULOMB FORCES IN THE NUCLEAR 1p SHELL. Anderson, R. K.; Wilson, M. R.; Goldhammer, Paul (Univ. of Kansas, Lawrence). Phys. Rev., C; 6: No. 1, 136-48(Jul 1972).

Correlated wave functions obtained by solving the Bethe–Goldstone equation with realistic nuclear interactions are employed to calculate Coulomb shifts, isospin mixing, Coulomb energies, and coefficients of the isobaric mass formula in 1p-shell nuclei. Improved agreement with experiment is obtained, particularly for the Coulomb shifts and isospin mixing which are not sensitive to the size parameter. No evidence is found favoring a charge-dependent component in the nuclear force. (auth)

42244 NOTE ON SELF-CONSISTENT CALCULATION OF SHELL EFFECTS. Bassichis, W. H. (Univ. of California, Livermore. Texas A and M Univ., College Station); Kerman, A. K. Phys. Rev., C; 6: No. 1, 370-2(Jul 1972).

Results of certain Hartree–Fock calculations, previously published, were obtained utilizing a computer program which contained an error. In this note the corrected results are presented. The suggestion of $Z = 120$ and $N = 184$ as magic numbers is not changed. (auth)

42245 ANGULAR DISTRIBUTION OF K ELECTRONS EJECTED DURING K CAPTURE BY POLARIZED NUCLEI. Intemann, R. L. (Temple Univ., Philadelphia). Phys. Rev., C; 6: No. 1, 211-17 (Jul 1972).

The angular distribution of the K electrons ejected during allowed K-capture transitions in polarized nuclei is calculated using a formalism previously developed by the author. It is shown that a result having a relative accuracy of order $Z\alpha$ may be obtained through the use of nonrelativistic electronic wave functions and a "semirelativistic" Coulomb Green's function due to Glauber and Martin. The result shows that, contrary to the predictions of previous theories, there is a noticeable asymmetry in the angular distribution of the ejected electrons, the asymmetry parameter being approximately a linear function of the electron's momentum. Possible experimental tests of the theory are described. (auth)

42246 SOME FORMULAS FOR THE BOUNDS ON THE ENERGY AND WAVE FUNCTIONS AND THEIR APPLICATIONS TO ^{20}Ne. Tewari, S. N. (Univ. of Arizona, Tucson). Phys. Rev., C; 6: No. 1, 179-87(Jul 1972).

The variational principle in quantum mechanics gives an upper bound on the energy eigenvalue E_k of the kth state if its trial wave function is orthogonal to the eigenfunctions of all the lower states. A lower bound on E_k has been derived assuming that: (i) its upper bound be less than E_{k+1}, and (ii) the energy fluctuation $(\langle H^2\rangle - \langle H\rangle^2)^{1/2}$ be less than $\frac{1}{2}(E_{k+1} - E_k)$. An upper bound on the error in the wave function of the kth state has also been derived. The formulas for the bounds have been applied to calculate the accuracy of the energies and wave functions of the various J states of the ground and excited $K = 0$ bands in ^{20}Ne. The intrinsic wave functions of the $K = 0$ bands were taken from the earlier calculations performed by using the deformed Hartree–Fock and Tamm–Dancoff approximations. Techniques for calculating $\langle H^2\rangle$ have also been discussed. The results show that the energies and wave functions calculated by these approximations are fairly accurate for a number of states. The wave functions of the ground and first excited $J = 0$ states are accurate at least to the order of 92.5 and 87.3%, respectively. (auth)

42247 STRIPPING TO ISOBARIC ANALOG RESONANCES. Agassi, D. (Weizmann Inst. of Science, Rehovot, Israel); Auerbach, N.; Moalem, A. Phys. Rev., C; 6: No. 1, 385-8(Jul 1972).

The form factor for the stripping distorted-wave Born-approximation amplitude to isobaric analog resonances is derived using a fine-structure theory of these resonances. It is found that the corrections due to compound-nucleus mixing are small. Using the derived form factor, the spectroscopic factors are calculated for the reaction ^{92}Mo(^{3}He,d)^{93}Tc. (auth)

42248 ROLE OF N MIXING IN NUCLEAR PROBLEMS USING NILSSON'S MODEL. Trainor, L. E. H.; Turner, R. J.; Tam, G.; Rosen, L. (Univ. of Toronto). Can. J. Phys.; 50: No. 8, 740-8 (15 Apr 1972).

The importance of major shell mixing in Nilsson's model is discussed with reference to calculations using Nilsson wave functions as a basis set. In particular it is shown that the N-mixing terms play an essential role in shaping the density distribution and are of paramount importance in determining electric quadrupole moments. Calculations also suggest that for each choice of deformation parameter there is an associated characteristic "shell structure". (auth) (Canada)

42249 PROPOSAL FOR A THEORETICAL INVESTIGATION OF THE EFFECT OF CRYSTAL FIELDS ON THE HALF-LIFE IN NUCLEAR BETA DECAY. Junker, K. (Swiss Federal Inst. for Reactor Research, Wuerenlingen, Switzerland). Acta Phys. Austr.; 34: No. 1-2, 117-32(1971).

Recent experiments claim a measurable influence of the chemical environment on the half-life in nuclear beta decay. This problem is investigated theoretically and a method is proposed which should enable the calculation of the order of this effect in ionic crystals. It is assumed that the Coulomb field of the chemical environment influences the wave function of the outgoing β-particle and thus the electrostatic potential of the surrounding atoms has to be included in the calculation of the Fermi screening function. (auth)

42250 BOUNDARY-CONDITION CONSTANTS OF THE LANE-ROBSON CALCULABLE THEORY. Mori, Akihiko (Tokyo Univ.). Phys. Rev., C; 5: No. 5, 1795-6(May 1972).

It is demonstrated that the S matrix derived from the Lane-Robson calculable theory of nuclear reactions is independent of the choice of the boundary-condition constants even if a truncated set of the basis states is used. (auth)

PHYSICS (PLASMA AND THERMONUCLEAR)

42251 PLASMA PHYSICS INDEX. THESAURUS 1972. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 21p.

This thesaurus comprises physical and technical terms serving as keywords for classifying literature in the field of plasma physics. The keywords are divided into four main groups: (1) properties, (2) phenomena, effects, and processes, (3) objects, and (4) methods. (M.O.W.)

42252 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. VOLUME 6, NO. 5, 1972. Bibliography, Author Index, Subject Index, Appendix. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 46p.

This listing contains 220 articles on various aspects of plasma physics and fusion reactors. (M.O.W.)

Confinement and Heating

Refer also to abstract 42315.

42253 (CONF-720705-1) COMPUTER SIMULATION OF ION HEATING BY PULSED MICROWAVES. Sprott, J. C. (Oak Ridge National Lab., Tenn.). 1972. 6p. Dep. NTIS.

From first topical conference on rf plasma heating; Lubbock, TX. (6 Jul 1972).

A numerical experiment is described in which an initially isotropic, homogeneous, Maxwellian electron distribution function in an axisymmetric, periodic mirror field is subjected to a pulse of microwave energy at the electron cyclotron frequency. The electron distribution is thereby perturbed, giving rise to large electric fields parallel to the magnetic field. The frequency spectrum of the electric fields is peaked at the electron plasma frequency. The initially cold ions are accelerated and stochastically heated by the electric fields. The observed heating rate is consistent with the prediction of a simple analytic model. (auth)

42254 (UCLA-34-P-157-X-3) INFRARED-LASER HEATING OF DENSE ARC PLASMAS TO SEVERAL MILLION DEGREES. Jassby, D. L. (California Univ., Los Angeles (USA). Plasma Engineering Lab.). Jan 1972. Contract AT(04-3)-34. 18p. (PELR-2; UCLA-ENG-7203). Dep. NTIS.

Extremely dense hydrogen arc plasmas can be heated to temperatures of 90 eV with presently available CO_2 lasers (10.6 μm) generating 25 joules in a 250-nsec pulse. Rapid heat diffusion prevents the attainment of significantly higher temperature unless the laser power is very much larger. Steady-state arc operation makes possible detailed measurements of energy-absorption and heat-conduction processes and allows utilization of the high repetition rate of CO_2 TEA lasers. With a simple TEA laser generating 1-joule, 200-nsec pulses, significant heating experiments are possible. (auth)

42255 (UCLA-34-P-157-X-4) THERMAL DECAY OF AN INFRARED-LASER HEATED ARC PLASMA. Jassby, D. L.; Marhic, M. E. (California Univ., Los Angeles (USA). Plasma Engineering Lab.). Mar 1972. Contract AT(04-3)-34. 11p. (PELR-4; UCLA-ENG-7222). Dep. NTIS.

A small region of a magnetically confined fully ionized arc plasma of density 2×10^{16} cm^{-3} and electron temperature of 1.3 to 1.7 eV is heated by 0.7 eV with pulsed CO_2-laser energy. The measured thermal decay is accounted for by classical collisional diffusion along the magnetic field. (auth)

42256 CROSSED-FIELD PLASMA DISCHARGES AT LOW PRESSURES. Pankratev, Yu. I.; Naboka, V. A.; Ponomarenko, E. F.; Lavrentev, O. A. (Physical-Technical Inst., Kharkov). Nucl. Fusion; 12: No. 3, 391-3(May 1972).

Studies were made of plasma accumulation in the electrostatic potential well created by the electron space charge. An electron gun produced an electron beam of 0 to 100 mA at an energy of 0 to 3 keV in a picket-fence magnetic trap. The liner at the positive potential was situated inside the magnetic coils. The cathode of the electron gun, the ring electrode and the diaphragm in the point cusp were kept at "earth" potential. The number of ions in the trap was determined by a measurement of the flux of ions escaping through the ring cusp. The measurements of ion-energy distribution and ion life-time were carried out after the injection impulse. Diagrams of the accumulation are given. (M.O.W.)

42257 INTERACTION BETWEEN A ROTATING ELECTROMAGNETIC FIELD AND A PLASMA CONTAINED IN A STRONG CONSTANT MAGNETIC FIELD. Demirkhanov, R. A.; Gutkin, T. I.; Kursanov, Yu. V.; (and others) (Physical-Technical Inst., Sukhumi, USSR). Nucl. Fusion; 12: No. 3, 363-6(May 1972).

Theoretical calculations and the results of experimental studies of the behavior of a plasma contained in a strong constant magnetic field when a rotating high-frequency field of dipole configuration with frequency Ω is superimposed upon it are presented. It is shown that for $\nu_{ei} > \Omega$ (where ν_{ei} is the frequency of collisions between electrons and ions) the high-frequency field excites an azimuthal electric current j_φ on the plasma surface. The interaction between the current j_φ and the constant magnetic field H_z generates a dynamic force, which forms the plasma into a column. The plasma is compressed into a column when the vector of the angular velocity of rotation of the high-frequency field $\vec{\Omega}$ and that of the constant magnetic field $\vec{H}_0$ coincide in direction. When the plasma is compressed into a column, there is no contact with the walls of the vacuum chamber and the degree of ionization is close to total. Probe and microwave measurements have shown that the time of compression of a plasma into a column for $H_z = 8 \times 10^3$ to 1×10^4 Oe is ~300 μs and the rate 6×10^3 cm/s. The diameter of the column was of the order of 2 to 3 cm. The charged-particle concentration measured with the help of superhigh-frequency waves (λ = 2 mm, 8 mm and 32 mm) was greater than 2×10^{14} cm^{-3} and decreased by more than two orders at a distance of 1 to 1.5 cm from the column center. When the vectors $\vec{\Omega}$ and $\vec{H}_0$ are opposite in direction, the force is directed away from the axis, and in this case, the plasma in the form of a hollow cylinder is situated at the vacuum-chamber walls. The maximum strength of the rotating high-frequency field at 1.25 MHz was 100 Oe. The results obtained show good agreement with the theoretical calculations. (auth)

42258 SOME ENGINEERING PROBLEMS OF LOW-FREQUENCY HEATING OF FUSION REACTORS. Cato, J. E.; Kristiansen, M.; Hagler, M. O. (Texas Tech Univ., Lubbock). Nucl. Fusion; 12: No. 3, 345-52(May 1972).

An engineering study of rf heating of fusion reactors is described. The frequency range considered is below 100 MHz. Special consideration is given to rf structures located between the reactor wall and the plasma in the main fusion region. Possible arcing problems in this region are discussed and it is found that they may not be too serious for neutral pressures below 10^{-4} torr. It is proposed to feed the rf through a slanted vacuum port in order to reduce port area and to protect the voltage insulator from radiation and temperature damage. The cooling of an rf coil structure is considered in detail. It is proposed to use a split rf coil composed of heat pipes to carry the heat away. Curves are presented which give the maximum rf on-time for various coil currents, frequencies, and coil sizes before the coil surface reaches melting temperature. Other coupling schemes involving the use of the vacuum wall as a rf structure or locating a wave launcher in the high-field region of a mirror reactor are discussed. In the case of a mirror reactor it is found that this last scheme may be quite attractive since unidirectional couplers can be made and experimental results indicate that the wave reflections may not be too serious in the severe-density and field gradients. This scheme also offers a possible way of launching, for instance, ion-cyclotron waves into very dense plasmas. It is concluded that the engineering problems of fusion-reactor-rf heating, albeit formidable, are not impossible. (auth)

42259 DECOUPLING OF CORONA AND CORE OF LASER-HEATED PELLETS. Kidder, R. E.; Zink, J. W. (Univ. of California, Livermore). Nucl. Fusion; 12: No. 3, 325-8(May 1972).

When a pellet of solid deuterium is heated in vacuum by convergent laser beams, the laser light is absorbed in a tenuous plasma corona surrounding a dense plasma core. If an attempt is made to heat the plasma too quickly, the corona electron temperature can decouple from that of the core, rising to a high value while the core temperature increases very little. This decoupling effect is examined quantitatively, and it is concluded that the effect may be severe for laser light whose wavelength much exceeds one micron. (auth)

42260 QUASI-LINEAR THEORY OF BEAM HEATING IN A NONUNIFORM PLASMA. Bliokh, Yu. P.; Shapiro, V. D.; Shevchenko, V. I. (Physical-Technical Inst., Kharkov). Nucl. Fusion; 12: No. 3, 301-6(May 1972).

A quasi-linear approximation was used to study the absorption of oscillations excited by an electron beam in a nonuniform plasma. The plasma electron distribution function was found to change with heating for two limiting cases: a plasma in a strong magnetic field, and a plasma without any field. (auth)

42261 AZIMUTHAL ELECTRIC FIELDS IN TOROIDAL TRANSPORT. Dum, C. T.; Pfirsch, D. (Max-Planck- Institut fuer Plasmaphysik, Garching, Ger.). Nucl. Fusion; 12: No. 3, 297-300(May 1972).

The role of azimuthal electric fields in toroidal transport is studied. A consistent kinetic theory for the collision-dominated regime is given and compared with a fluid calculation. The weakly collisional and intermediate regimes are also discussed. (auth)

42262 COMPUTER SIMULATION OF rf-CONFINEMENT OF PLASMAS IN AN OPEN-ENDED TOROIDAL QUADRUPOLE. Abe, Hirotada; Kawai, Kazuhiro; Yamada, Teruhiko; Itatani, Ryobei (Kyoto Univ.). J. Phys. Soc. Jap.; 33: No. 1, 216-24(Jul 1972).

Collisional diffusions of plasmas contained in an open-ended toroidal quadrupole magnetic field and an improvement of an energy confinement with the aid of applying an rf-electric field are numerically simulated. As a technical method, some modifications to the collisionless PIC method are introduced. The plasma decreases at the rate inferred from the collisions acting on the ions. The improvements in energy containment by applying rf-electric fields are suggested, especially by tracing the motion of some test particles. (auth)

42263 MECHANISM OF PLASMA HEATING BY AN ELECTRON BEAM IN A MIRROR TRAP. Demirkhanov, R. A.; Gevorkov, A. K.; Popov, A. F.; Kolmakov, O. A. JETP Lett. (USSR) (Engl. Transl.); 15: No. 7, 274-7(5 Apr 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 7, 389-94(5 Apr 1972).

A detailed investigation was made of the spectra of the oscillations excited by a beam in a plasma and the mechanism of their absorption in an open magnetic trap. The electron beam current was varied from 10 to 200 mA at an energy up to 5 keV in a continuous regime. The oscillation spectra are described. (M.O.W.)

42264 SCHROEDINGER-LIKE EQUATIONS FOR THE NONADIABATIC ESCAPE OF CHARGED PARTICLES. Varma, R. K.; Horton, C. W. Jr. (Univ. of Texas, Austin). Phys. Fluids; 15: No. 8, 1469-73(Aug 1972).

The Schroedinger-like equations for the nonadiabatic escape of charged particles from magnetic mirror traps are derived, starting from the integral equation for the evolution of the quantum mechanical wave-function for the problem. A connection is thus established between the wavefunction of quantum mechanics and the wavefunction describing the nonadiabatic behavior. At the same time, the derivation of these equations given here justifies the ansatz used in an earlier derivation. (auth)

Diagnostics

42265 ALPHA-PARTICLE PROBING OF CURRENT DISTRIBUTION IN AN AXISYMMETRIC PLASMA COLUMN. Kawasaki, S.; Inoue, K. (Japan Atomic Energy Research Inst., Tokai). Nucl. Fusion; 12: No. 3, 387-9(May 1972).

A scheme is proposed for the measurement with α-particles emitted from a radioisotope related to the Tokamak, JFT-2. The α-source is located outside the plasma, the beams are injected into the plasma in the plane perpendicular to the axis, deflected from the normal orbit by a Lorentz force, $V_r \times B_\theta$, and then detected outside the plasma. Under the assumption that the field parameters depend only on the radius, the distribution of the magnetic field could be determined uniquely by using multiple α-beams with various energies, injection angles or source positions. (M.O.W.)

42266 LASER-BEAM-SCATTERING MEASUREMENT OF ION TEMPERATURE IN A θ-PINCH PLASMA AND EVIDENCE FOR THERMONUCLEAR REACTIONS. John, P. K. (National Research Council of Canada, Ottawa). Phys. Rev., A; 6: No. 2, 756-64(Aug 1972).

Results are reported on an experiment to measure the ion temperature in a 100-kJ θ-pinch deuterium plasma. A ruby laser was used for scattering observations at 5° and 90° using multichannel spectrum analyzers and gave $n = 1.05 \times 10^{17}$ cm^{-3} and $T_i = 300$ eV. An independent measurement of the density was made by means of Rayleigh scattering. The neutron yield from the plasma was measured to be 8×10^8 sec^{-1}. The observed neutron emission was compared with that expected from a plasma with an ion temperature of 300 eV and was found to be of thermonuclear origin. (auth)

42267 MEASUREMENTS OF THE PLASMA SHEATH CAPACITANCE USING A SIMPLE TUNNEL DIODE OSCILLATOR. Oliver, B. M.; Clements, R. M. (Univ. of Victoria, British Columbia). J. Phys., E (London); 5: No. 7, 718-20(Jul 1972).

A tunnel diode oscillator is used to obtain accurate measurements of the capacitance of the plasma sheath surrounding a cylindrical Langmuir probe in a collisionless plasma. The probe is biased in the ion saturation current region with probe potentials ranging from 17 to 220 V. A comparison of these results with similar data obtained using a simple LC resonant circuit is made and shows the technique to be a simple, precise diagnostic tool which should be generally applicable both for laboratory and upper atmospheric plasmas. (auth)

42268 INFRARED SCHLIEREN INTERFEROMETER FOR MEASURING ELECTRON DENSITY PROFILES. Keilmann, F. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Plasma Phys.; 14: No. 2, 111-22(Feb 1972).

In rotationally symmetric plasmas the electron density profiles can be determined from refractive index effects, preferably by using infrared radiation. The diagnostic value of schlieren techniques is compared to that of interferometry. As a very efficient diagnostic setup, a combined schlieren interferometer is introduced, which makes use of the plasma itself as a beam-splitter. Experimentally, arc plasmas are investigated using the infrared radiation of a CO_2-laser at 10.6 μ wavelength. (auth)

42269 COIL SYSTEMS FOR MEASURING ROTATIONAL ASYMMETRIES IN THE SELF-MAGNETIC FIELD OF A DISCHARGE. van Heijningen, R. J. J.; Maris, D. J.; Bobeldijk, C.; van der Laan, P. C. T. (FOM-Instituut voor Plasma-Fysica, Jutphaas, Netherlands). Plasma Phys.; 14: No. 2, 205-7(Feb 1972).

A continuous coil encircling a plasma discharge tube is described, similar to a Rogowski coil but differing from it in that the number of turns per unit length is not constant but varies as the sine or cosine of the azimuthal angle. The output of the sine-cosine coil is related to displacement of the current channel, and for small displacements is directly proportional to the displacement. (UK)

42270 PULSED X-RAY STUDY OF SHOCK WAVES IN DENSE CESIUM VAPOR. Lomakin, B. N.; Fortov, V. E. (Moscow Physical-Technical Inst.). High Temp. (USSR) (Engl. Transl.); 9: No. 6, 1188-90(Nov-Dec 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 6, 1291-3(Nov-Dec 1971).

The equation of state of the nonideal plasma is determined in this case from the measurements of any two parameters characterizing the shock wave, with subsequent use of conservation laws at the discontinuity front. The front velocity is undoubtedly the quantity easiest to measure. Analysis of the errors of shock-wave measurements has shown that in the case of gaseous media the parameter second easiest to measure is the density (the heavy-particle density $N = N_i + N_a$) of the plasma, which can be determined highly accurately by a pulsed x-ray method. Measurements of x-ray absorption in cesium are described. (M.O.W.)

42271 TEMPERATURE PROFILE DETERMINATION IN AN ABSORBING PLASMA. Usher, J. L.; Campbell, H. D. (Univ. of Florida, Gainesville). J. Quant. Spectrosc. Radiative Transfer; 12: No. 7, 1157-60(Jul 1972).

A new method was developed to determine the temperature profile of an optically thick plasma. The technique is essentially an extension of the brightness-emissivity method to the case of a cylindrically symmetric plasma. (auth)

Kinetics (General)

42272 (LYCEN-7205) APPLICATION OF THE MONTE CARLO METHOD TO THE DETERMINATION OF THE PLACES WHERE IONS ARE FORMED IN A PENNING SOURCE AS A FUNCTION OF THE MAGNETIC FIELD. Hadinger, G.; Hadinger-Espi, G.; Tauth, T.; Ilgen, J.; Jacoby, W. (Lyon Univ. (France). Institut de Physique Nucleaire). Jan 1972. 22p. (In French). Dep. NTIS (U. S. Sales Only).

A means by which the elementary processes taking place in a plasma arc discharge can be studied was developed. This study led to a way of localizing the formation of multicharged ions. The method was applied to PIG ion sources in an inhomogeneous field. It is hoped that the preliminary results will be adequate to determine an optimum field configuration. (France)

42273 (SC-B-723233) BIBLIOGRAPHY ON ARC DISCHARGES. Bacon, F. M.; Grissom, J. T.; Mangan, D. L.; McClure, G. W.; Newton, J. C. (Sandia Labs., Albuquerque, N. Mex.). Jun 1972. 163p. Dep. NTIS.

This bibliography was compiled during a survey of past research on arc discharges in vacuum and in gaseous atmospheres. For the purpose of this study, an arc is defined as a discharge carrying a current greater than about one ampere. Most of the listed references discuss theoretical and experimental aspects of the constricted current-carrying zones on the electrodes known as cathode and anode spots. The bibliography is subdivided into the major categories: General Arc Phenomena, Applications, Cathode Phenomena, Anode Phenomena, and Plasma Phenomena. Each major category is subdivided into a number of sections dealing with important subtopics. References are arranged within each section in chronological order. (auth)

42274 LEVEL DENSITIES OF HELIUM- AND LITHIUM-LIKE IONS. Galushkin, Yu. I. This paper was summarized in At. Energ. (USSR); 31: No. 3, 274(Sep 1971) as paper No. 530/6204. (In Russian).

Full copy of this paper is held by TIC.

Calculations are made of densities of ground states and excited states of helium- and lithium-like ions with a nuclear charge $5 \leq Z \leq 18$ at electron temperatures $0.05 \leq kT/Z^2Ry \leq 3$ ($Ry = 13.6$ eV) and densities n_e comprising the entire interval from the limiting cases of corona equilibrium to Boltzman equilibrium. The case of a stationary plasma which is "optically thin" for its intrinsic emission was considered. Radiation and collision processes producing transitions from a given level to all lower and higher levels (including the continuum), as well as transitions from these levels to a particular level (in the optically thin model) were taken into account in the equations for the level densities. The corresponding rates of the processes were considered. The equations were solved under the assumption that the values $\rho(Z-k, p) = n(Z-k,p)/n(Z-k+1.1)$ do not differ from the Boltzmann distribution for all $p \geq 11$ [$n(Z-k, p)$ denotes the level density p of the ion with the charge $Z-k$; p denotes the number of the ion state; and $p = 1$ denotes the ground state of the ion]. The densities of the 1^1S, 2^1P, and 2^3S2^3P levels of helium-like ions and of the 2^2S, 3^2S, and 3^2P3^2D levels of lithium-like ions are stated in the form of tables and diagrams. (auth)

42275 CONTROLLING THE OSCILLATION SPECTRUM IN THE BEAM–PLASMA SYSTEM USING EXTERNAL MODULATION. Bakai, A. S.; Kornilov, E. A.; Krivoruchko, S. M. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 16: No. 9, 1526-9(Sep 1971).

Translated from Radiotekh. Elektron.; 16: No. 9, 1680-4(Sep 1971).

The mechanism of controlling the oscillation spectrum in the beam–plasma system by means of external high-frequency signal is theoretically and experimentally studied. It is established that nonlinear interaction between the waves excited by the beam leads to a narrowing of the high-frequency oscillation spectrum. (auth)

42276 POLARIZATION ELECTRIC FIELDS AND DEPOLARIZATION CURRENTS OF PLASMA MOVING IN THE MAGNETIC FIELD OF A TOROIDAL SOLENOID WITH A DIVERTOR. Zykov, V. G.; Karpukhin, V. I.; Lonin, Yu. F.; Rudnev, N. I. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 10, 1602-8(Oct 1971). (In Russian).

Polarization electric fields and depolarization currents of plasma moving along the toroidal magnetic field are studied. When the divertor configuration is situated between the plasma gun and the U-bend, full stabilization of the plazma motion with regard to the toroidal drift is shown to be possible in a rather wide interval for the values of the plasma longitudinal motion. (auth)

42277 COLLISIONLESS RELAXATION IN PLASMA OF INTERPENETRATING ION FLUXES. Borisenko, A. G.; Kirichenko, G. S. (Inst. of Nuclear Research, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 10, 1727-9(Oct 1971). (In Russian).

The nonlinear interaction of two mutually penetrating ion beams of comparable density moving in a plasma without a magnetic field was investigated. For a relative velocity of the beam $\Delta V \sim C = (T_e/M_i)^{1/2}$ and during the course of several periods of ionic Langmuir frequency, a strong deformation of the ion velocity distribution function develops. As a rule, a broadening of the spectrum of beam velocities occurs asymmetrically relative to their average velocities. Nonlinear interaction also is accompanied by a broadening of the frequency region of excited ion-acoustic oscillations. (tr-auth)

42278 LABORATORY STUDY OF HIGH-β PLASMA SHOCK WAVES. Morse, D. L.; Destler, W. W. (Cornell Univ., Ithaca, N. Y.). Plasma Phys.; 14: No. 2, 153-65(Feb 1972).

A plasma wind tunnel was used to generate shock waves at rest in the laboratory reference frame. The upstream pressure ratio β is in the range 1 to 3, and the Mach number based on the fast magnetosonic wave speed is 3 to 5. The shock wave is formed by letting the plasma "wind" impinge on the field of a magnetic obstacle. The resulting shock is primarily transverse, and exhibits a thickness of 0.8 to 1.2 times the ion inertial length c/ω_{pi}. The shock thickness decreases with increasing Mach number, and increases as the ion mass is increased. Measured values of upstream and downstream magnetic field, particle density, and temperature agree with those calculated from the shock conservation relations. Magnetic fluctuations in the shock front are observed, with frequencies near the ion cyclotron frequency. Comparisons of these results with those of other experiments, and with the Earth's bow shock, are made. (auth)

42279 INDICATIONS OF ANOMALOUS DIFFUSION IN AN ION ENGINE DISCHARGE. Martin, Anthony R. (City Univ., London). Plasma Phys.; 14: No. 2, 123-32(Feb 1972).

The phenomenon of micro-anomalous diffusion, as distinct from macro-anomalous diffusion where the system is hydrodynamically unstable, is investigated in the discharge chambers of a series of electron-bombardment ion engines with varying diameters. It is found that there are several experimental methods which can be used to determine a value of the critical magnetic flux density above which anomalous diffusion occurs. The methods give consistent results among themselves, and agree well with instability theories which also predict a critical flux density. (auth)

42280 DIRECT MEASUREMENTS OF THE INDEPENDENT DIFFUSION OF PLASMA IONS AND ELECTRONS ACROSS A MAGNETIC FIELD IN A BOUNDED CONDUCTING CYLINDER. Pasechnik, L. L.; Popovich, A. S.; Naumovets, V. G. This paper was summarized in At. Energ. (USSR); 31: No. 3, 275-6 (Sep 1971) as paper No. 532/6239. (In Russian).

Full copy of this paper is held by TIC.

An investigation was made of the diffusion of charged plasma particles bounded by conducting walls and placed in a magnetic field. The plasma was produced in a metal cylinder (length 40 cm and diameter 4.5 cm) between the grid and an end electrode that were electrically connected. Gas ionization was produced by an electron beam from the heated cathode located behind the grid. The cathode voltage with respect to the cylinder (anode) was ~100–300 V, the emission current from the cathode was ~50 to 300 mA, the gas (helium) pressure was $p = 3 \times 10^{-2}$ to 10^{-1} mm Hg, the magnetic field intensity was $H = 300$ to 1500 Oe, and the electron temperature was $T \approx 1$ eV. Experimental and calculated values are given for the time of motion of electrons (τ_e) and of ions (τ_i) from the axis of the system to the walls under various conditions for a potential of the ends with respect to the side wall of the cylinder $U_{end} = 0$. The calculated values of τ were found from the relation $D_{e,i} \cdot \tau_{e,i} = 4R^2$, where R is the chamber radius; $D_{e,i}$ is the coefficient of diffusion of electrons (ions) across the magnetic field, resulting from collisions of charged particles with gas atoms. In the calculations, T_e and T_i were taken equal to 1 eV and 0.1 eV, respectively. (auth)

42281 PLASMA FLOW CHARACTERISTICS IN AN ARC CHANNEL. Asinovskii, E. I.; Pakhomov, E. P.; Yartsev, I. M. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Eng. Transl.); 9: No. 6, 1031-6(Nov-Dec 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 6, 1119-25(Nov-Dec 1971).

An apparatus constituting a dc arc stabilized by means of a cooled wall and intended for the experimental determination of plasma viscosity and various other characteristics of plasma flow in an arc channel is described, together with some of the methods employed for this purpose, and also certain results obtained for plasma flow in an arc with a channel 3 cm in diameter and the general characteristics of this arc. Means of calibrating the pressure-head tube used for measurements in plasma flows involving a high viscosity correction are discussed. (auth)

42282 CONDITIONS FOR THE PRODUCTION OF ROTATIONAL ANNULAR BEAMS OF RELATIVISTIC ELECTRONS USING A CUSPED MAGNETIC FIELD. Friedman, M.; Sprangle, P. (Cornell Univ., New York). Plasma Phys.; 14: No. 2, 107-10(Feb 1972).

Some of the parameters needed to produce a rotating annular beam of relativistic electrons are examined, and conditions are derived for electrons to be reflected from the magnetic cusp, and for the oscillating radial velocity. (UK)

42283 STUDY OF A HIGH-PRESSURE THERMAL ARGON PLASMA AS A HIGH-RADIANCE STANDARD. Goldbach, Claudine; Nollez, Gerard; Peyturaux, Roger (Institut d'Astrophysique, Paris). J. Quant. Spectrosc. Radiative Transfer; 12: No. 7, 1089-1104(Jul 1972).

This work represents a first step in the realization of a plasma source emitting blackbody radiation. A theoretical evaluation of the conditions to be fulfilled in order to obtain strictly planckian radiation from a pure argon plasma was made. The plasma generator is a wall-stabilized arc 49 mm in length, burning stably under pressure as high as 50 atm. Spectroscopic diagnostics of the plasma were performed by using various methods and using the hypothesis that L.T.E. obtains. For a constant value of the electrical intensity (150 A), the electronic temperature decreases from about 14,000°K at atmospheric pressure to about 11,500°K at 50 atm. The continuous radiation was measured between 1 and 50 atm.; the values of the monochromatic brightness temperature were deduced from it and compared with the value of the electronic temperature. For the maximum values of pressure, length, and temperature, the emitted radiation is not Planckian but the brightness temperature T_L of the continuum remains constant in a wide spectral range ($3500 \leq \lambda[A] \leq 6500$). In addition, discrepancies also appear between the theoretical forecasts and the experimental values. However, the arc which was realized can constitute a useful reference source of high radiance in the visible and near uv range, because of its time stability and of the reproducibility of the emitted light intensities. (auth)

42284 NONLINEAR EIGENVALUE PROBLEM OF A SELF-SUSTAINED ELECTRICAL DISCHARGE. Wilhelm, H. E. (Colorado State Univ., Fort Collins). Can. J. Phys.; 50: No. 11, 1156-62(1 Jun 1972).

An analytical solution is presented for the nonlinear boundary-value problem of a one-dimensional, electrical model discharge, in which the production of plasma by ionization is balanced by the plasma losses due to recombination and diffusion. The maximum value ($\hat{n}$) of the electron–ion density in the center of the discharge is given as the positive-real eigenvalue of a transcendental equation resulting from the boundary conditions. It is shown that a self-sustained, steady-state discharge exists if the dimensionless discharge number $Z \equiv (2/\pi)\, a\sqrt{\epsilon/D}$ is numerically equal to a certain function $\Phi(\hat{N})$ of the dimensionless eigenvalue $\hat{N} = 2\alpha\hat{n}/3\epsilon$. For example, it must be (i) $Z = \Phi(\hat{N}) = 1$ for $\hat{N} = 0$, i.e., when recombination is neglected, $\alpha = 0$, and (ii) $Z = \Phi(\hat{N}) > 1$ for $\hat{N} > 0$, i.e., when recombination is considered, $\alpha > 0$ (a = half wall distance; ϵ, D, α = ionization, diffusion, and recombination coefficients respectively). Plots of the eigenvalue $\hat{N}$ versus Z and of the density distribution n(x) of the charged particles are given. (auth) (Canada)

42285 PLASMA ACCELERATOR WITH CLOSED ELECTRON DRIFT AND EXTENDED ACCELERATION ZONE. Morozov, A. I.; Esinchuk, Yu. V.; Tilinin, G. N.; (and others). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 1, 38-45(Jul 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 1, 54-63(Jan 1972).

Accelerators with "closed" electron drift and extended acceleration zone (ACED) are the simplest and most promising of the stationary electromagnetic plasma accelerators; in these accelerators ions are accelerated by the electric field that develops in the plasma. The present work initiates a series of experimental and theoretical investigations of the "single-lens" variant of ACED. The experiments were performed with N_2, Ar, Kr, Xe as working gases at voltages U_d up to 1000 V and discharge currents $I_d \simeq 15$ A. A schematic diagram of the accelerator is shown; the dimensions of one model are also indicated. (M.O.W.)

Kinetics (Experimental)

42286 PHASE FOCUSING AND ASSOCIATED NONLINEAR PHENOMENA DURING INTERACTION OF AN ION BEAM WITH A PLASMA. Gabovich, M. D.; Soloshenko, I. A.; Simonenko, L. S. (Inst. of Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 10, 1747-9(Oct 1971). (In Russian).

Phase focusing, energy losses, and the appearance of "anomalously" fast ions were studied under conditions of excitation of Langmuir electron oscillation of a plasma by an ion beam. The experiments were conducted with a 30 keV beam of H_2^+ ions (20 mA). The plasma was produced by the beam itself as a result of ionization of the neutral gas. The distribution of the amplitude of the fundamental harmonics along the beam axis was measured. (K.S.W.)

42287 NONTHERMAL RADIATION FROM A MAGNETOACTIVE PLASMA IN THE FIELD OF AN ULTRA-HIGH-FREQUENCY PUMPING WAVE. Batanov, G. M.; Sarksyan, K. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1721-4(May 1972). (In Russian).

The ultra-high frequency radiation from a collisionless magnetized plasma interacting with an intense pumping wave in the uhf range is investigated experimentally. Red and blue satellites in the emission spectrum induced by the first harmonic of the pumping wave ω_0 are observed which are shifted by $\Delta\omega \sim \omega_{Li}$ with respect to the central peak, ω_{Li} being the ion Langmuir frequency. This indicates that extreme short-wave ion oscillations are built up. Emission due to the second harmonic of the pumping wave ($2\omega_0$) is detected; its intensity exponentially increases with growth of intensity of the incident wave. The satellite excitation effects and emission due to the second harmonic of the pumping wave correlate with anomalous absorption and heating effects and can be explained by parametric excitation of plasma oscillations. (auth)

42288 POSSIBILITY OF BETATRON ACCELERATION MECHANISM IN A θ-PINCH WITH AZIMUTHAL MAGNETIC FIELD. El-Khalafawy, T. A.; Youssef, A. M.; Diatlov, V. G.; Volkov, Ya. F. (Atomic Energy Establishment, Cario). Plasma Phys.; 14: No. 2, 103-10(Feb 1972).

The possibility of runaway-electron betatron acceleration is treated. It is shown that in a theta-pinch plasma with an azimuthal magnetic field the reverse axial magnetic field may have a betatron configuration with a life-time about 5 μsec. The average energy of accelerated electrons approaches 1 MeV. The experimental x-ray energy agrees with that which the runaway electrons would obtain under betatron acceleration. The betatron conditions and the beam of accelerated electrons disrupt due to inherent plasma processes. (auth)

42289 USE OF THE DOPPLER EFFECT FOR MEASURING PLASMA VELOCITY. Goloborod'ko, V. T.; Kiselev, Yu. M. (Kharkov Scientific-Research Inst. of Metrology). High Temp. (USSR) (Engl. Transl.); 9: No. 6, 1148-52(Nov-Dec 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 6, 1248-52(Nov-Dec 1971).

An apparatus and method for measuring the velocity of the directional movement of plasma, as well as high-resolution spectrometers, ensuring measurement of the velocity according to the plasma radiation itself in the range 10^3 to 10^6 m/sec with an error of 3%, are described. The interpretation of the results of measurements in the case of recording of the Doppler shift of spectral lines is discussed. (auth)

42290 DYNAMICS OF THE INVERSE PINCH. Weisbach, Michael F.; Ahlstrom, Harlow G. (Univ. of Washington, Seattle). Phys. Fluids; 15: No. 8, 1459-68(Aug 1972).

Experiments are performed on the plasma produced in a large inverse pinch using argon with no applied magnetic fields or preheating. A direct observation is made of the precursor ionization, which initially raises the electron temperature and electrical conductivity. Calculations show that most of the mass is entrained in the current sheet, but that less than complete sweeping occurs at the lower velocities. The shock, which is embedded in the current sheet, closely resembles an ordinary gasdynamic shock. Consideration of the shock jump condition derived from the induction equation is shown to determine the frequent inability of the shock to separate from the current sheet. (auth)

42291 PLASMA ELECTRON VELOCITY DISTRIBUTIONS DETERMINED FROM THE POLARIZATION OF FREE–FREE BREMSSTRAHLUNG. Raimbault, P. A.; Shohet, J. L. (Univ. of Wisconsin, Madison). Phys. Fluids; 15: No. 8, 1477-83(Aug 1972).

The degree of polarization of the free–free bremsstrahlung from a plasma, as measured by Compton scattering, may be used to determine the electron velocity distribution. In this experiment, a hot electron plasma was made by means of electron cyclotron resonance heating in a magnetic mirror. The measured degree of polarization varied as mirror ratio and amount of lower off-resonance heating were changed. A theoretical computation of polarization, utilizing a nonrelativistic quantum mechanical theory, which matched the experimental conditions, showed that either a loss-cone or a Harris distribution could fit the observed data, except when lower off-resonance heating filled the loss cone. Under these conditions, only the Harris distribution was correct. (auth)

Kinetics (Theoretical)

42292 PLASMA DISTRIBUTION FUNCTION NEAR THE LOSS CONE OF A MIRROR MACHINE. Baldwin, D. E. (Univ. of California, Livermore); Cordey, J. G.; Watson, C. J. H. Nucl. Fusion; 12: No. 3, 307-14(May 1972).

The particle distribution in phase space near the loss cone of a stable mirror machine is determined by an asymptotic analysis based on the smallness of λ, the ratio of transit between mirrors to mean collision time. Away from the loss cone, the solution is obtained by averaging over a bounce motion. Near the loss cone, i.e., within a distance scaling as $\lambda^{1/2}$, the governing equations are converted into a Wiener–Hopf equation along a boundary line in phase space whose solution yields the desired distribution. It is found that the ratio of plasma density in the mirror throat to central density scales as $\lambda^{1/2}$, while the ratio of external density to central density scales as λ. For typical reactor conditions, these ratios correspond to densities of 10^{11} cm^{-3} and 10^8, respectively. Since the distance over which this drop occurs, scales as $\lambda^{1/2}$ times the local magnetic scale length, it is necessary to reexamine the reflection of unstable plasma waves in the neighborhood of the mirrors. (auth)

42293 DETERMINATION OF THE AVERAGE DIFFUSION TIME OF CHARGES IN A CONFINED PLASMA. Gurin, A. A.; Pasechnik, L. L.; Popovich, A. S. (Inst. of Nuclear Research, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 12, 2072-4(Dec 1971). (In Russian).

The effect of charge diffusion longitudinal with respect to a magnetic field was investigated on the basis of diffusion processes with absorption. Diffuse motion across the magnetic field in a confined plasma was then postulated. Calculations were conducted for a finite-length cylinder with a source of test particles at the axis and a collector located at a lateral surface. Diffusion coefficients across the magnetic field within the confined system were thus calculated, using data of the averaged time of motion from the axis to the collector. (tr-auth)

42294 NONLINEAR THEORY OF KINETIC INSTABILITY OF AN ELECTRON BEAM IN A PLASMA. Levin, M. B.; Lyubarskii, M. G.; Onishchenko, I. N.; Shapiro, V. D.; Shevchenko, V. I. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1725-32(May 1972). (In Russian).

A nonlinear theory of monochromatic wave excitation due to a "gentle" hump on the electron distribution function is developed. By an appropriate choice of dimensionless variables, the equation set describing wave excitation by resonance particles of the beam and their motion under the action of the wave field can be reduced to a "universal" set, i.e., to one which is independent of the beam and plasma parameters. Numerical methods are employed for solving the equation set thus obtained. The dependence of the wave amplitude on time under nonlinear conditions is determined and characteristic trajectories of the resonance particles on the phase plane are investigated. (auth)

42295 ANOMALOUS SKIN EFFECT IN A PLASMA WITH A DIFFUSE BOUNDARY. Liberman, M. A.; Meierovich, B. E.; Pitaevskii, L. P. (Physical Lab., Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1737-44(May 1972). (In Russian).

Penetration of an electromagnetic wave into a plasma, in which the electron concentration is a prescribed function of the coordinates, is considered under anomalous skin effect conditions. An integral equation for the electromagnetic field in a plasma is derived for an arbitrary relation between the electron mean free path, field penetration depth and size of the transition region at the boundary. An exact solution of the integral equation is obtained for the case when the electron concentration depends on the coordinate exponentially and the mean free path is infinite. The surface resistance and reflection coefficient are calculated. (auth)

42296 BEAM INSTABILITY IN THE PRESENCE OF TRAPPED ELECTRONS. Korshunov, S. M. (Moscow Physical-Technical Inst.). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1764-9 (May 1972). (In Russian).

Oscillations of the space charge in an electron beam passing through a region with trapped electrons are considered in the geometrical optics approximation. It is shown that the presence of trapped particles leads to the appearance of instabilities in the beam. For perturbation frequencies such that $\omega \ll \Omega$ and $\omega \gg \Omega$, where Ω is the captured electron oscillation frequency, instability of the beam type develops. For perturbation frequencies $\omega = \pm n\Omega$, the instability is due to resonant interaction between the captured electrons and plane wave field. (auth)

42297 KINETIC EQUATIONS FOR A CLASSICAL NONIDEAL PLASMA. Klimontovich, Yu. L. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1770-81(May 1972). (In Russian).

The Boltzmann, Landau, Balescu–Lenard equations for a plasma do not take into account sufficiently particle interaction within the framework of the respective models. These equations, for example, lead to the law of conservation of kinetic energy and hence do not make allowance for the contribution of the interaction to the internal energy of the plasma. The contribution of correlations to the entropy is also not taken into account. In an earlier article (Zh. Eksp. Teor. Fiz., 60: 1352 (1971)) the author analyzed the Boltzmann equation, and the interaction was completely taken into account within the framework of the pair collision approximation. Here, an effort is made to derive a similar kinetic equation for a plasma in a first approximation with respect to the plasma parameter. Because of the necessity of taking into account polarization, this problem is much more difficult than that considered earlier, and a different approach is required for its solution. The collision integral obtained diverges at small distances, just as the collision integral in the Balescu–Lenard approximation does. Various forms of the collision integrals (combinations of the Boltzmann, Landau, Balescu–Lenard collision integrals) have been proposed recently that converge at both large and small distances. However, the corresponding thermodynamic functions are not entirely correct. The Boltzmann kinetic equation is derived here for a nonideal plasma by taking into account the velocity-average contribution of the plasmadynamic polarizability. The collision integral converges at small and large distances. At small distances the corresponding correlation function goes over to an expression for the pair collision approximation, and at large distances and in a first approximation with respect to the plasma parameter it is identical to the Debye correlation function. A consequence of this is that correct expressions are obtained for the thermodynamic functions. (auth)

42298 CLASSICAL THERMAL CONDUCTIVITY OF A STATIONARY TOROIDAL PLASMA. Maschke, E. K. (CEN, Fontenay-aux-Roses, France). Plasma Phys.; 14: No. 2, 141-51(Feb 1972).

The differential equation for the ion heat flux parallel to the magnetic field is solved for non-rotating, but otherwise arbitrary, MHD equilibria. A general expression for the effective thermal conductivity is obtained, which has the same structure as the general form of the Pfirsch–Schlueter factor of classical diffusion. In the case of a Tokamak type equilibrium with an elliptic cross section of the plasma ring, the effective thermal conductivity is calculated assuming large aspect ratio, but finite β. At sufficiently high β the average rotational transform goes to zero at the plasma boundary, but the effective thermal conductivity remains finite. The maximum temperature attainable with Ohmic heating in a plasma with elliptical cross section is calculated. (auth)

42299 IONIZATION EQUILIBRIUM AND STABILITY OF A QUANTUM PLASMA. Saendig, R.; Ebeling, W. (Rostock Univ., Ger.). High Temp. (USSR) (Engl. Transl.); 9: No. 6, 1197-9 (Nov-Dec 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 6, 1298-1300 (Nov-Dec 1971).

Corrections are made to earlier calculations (W. Ebeling, Physica, 43: 293 (1969)) of ionization equilibrium of quantum plasmas. Higher densities are considered here. Thermodynamic stability boundaries are outlined. (M.O.W.)

42300 ELECTRICAL CONDUCTIVITY OF A NONIDEAL LOW-TEMPERATURE PLASMA AND ITS METALLIZATION. Khrapak, A. G.; Yakubov, I. T. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 6, 1050-60(Nov-Dec 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 6, 1139-50(Nov-Dec 1971).

For strong compression of a plasma from gas densities to densities of the order of metallic densities, the electrical conductivity increases by several orders. During the first stage of this process the ideal nondegenerate plasma has properties characteristic of certain semiconductors. Its electrical conductivity can be calculated according to the Kubo formula, with allowance for the interaction of charged particles with neutrals, which is strong. At still higher densities during the second stage of metallization, the plasma evidently becomes a heterogeneous system. This allows an explanation to be given for certain anomalous dependences, observed, in particular, in a plasma consisting of mercury vapors. (auth)

42301 STRIATIONS IN A TRANSVERSE MAGNETIC FIELD. Igitkhanov, Yu. L.; Kruzhilin, N. A.; Nedospasov, A. V.; Petrov, V. G.; Yakubov, I. T. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 6, 1037-41(Nov-Dec 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 6, 1126-30(Nov-Dec 1971).

The case is examined in which a transverse magnetic field is applied to a plasma which has a high level of inelastic losses and a significant amount of ambipolar diffusion. It is shown that the plasma is subject to instabilities, even when the admixture is totally ionized. (auth)

42302 APPLICATION OF IRREVERSIBLE THERMODYNAMICS ON THE PROCESSES TAKING PLACE IN A PLASMA. Hedai, Lajos. Energ. Atomtech.; 24: No. 3, 142-3(Mar 1971). (In Hungarian).

To describe a large number of complex processes in nonequilibrium ionized and dissociated mixtures of gases the methods of irreversible thermodynamics were used. This deals with the mass and energy transports as well as the mutual effects of materials in macroscopic scales. After describing the considerations basing the calculating methods of irreversible thermodynamics, the author discusses the permanency and balance equations in the language of mathematics and then they are applied to plasma processes. (auth)

42303 STATISTICAL MECHANICS OF MAGNETO-ACTIVE PLASMA. Pratap, R.; Sridhar, R. (Inst. of Mathematical Sciences, Madras). Nuovo Cim.; 9B: No. 2, 279-98(11 Jun 1972).

The statistical mechanics of magnetoactive plasma was formulated in the framework of irreversible statistical mechanics. Starting from the formal solution of the complete Liouville equation, the one-particle distribution function was obtained. The quantum effects which become dominant at low temperatures were incorporated by preparing the initial state using the Landau wave functions. Thus, the theory can be extended to low temperatures with a weak magnetic field. The microinstabilities that are usually discussed in plasma physics can be derived from the present results by taking proper limiting processes. (auth)

42304 BASIC INTERACTIONS IN REAL PLASMAS AND IN THE PLASMAS OF NUMERICAL EXPERIMENTS. Sestero, A. (EURATOM-CNEN, Frascati, Italy). Nuovo Cim.; 9B: No. 2, 222-32(11 Jun 1972).

The difficulties of the numerical simulation of plasmas are examined, emphasis being laid on basic physical rather than numerical issues. (auth)

42305 DETECTION PROPERTIES OF A PLASMA. Zantberg, Yu. L.; Kononenko, K. I.; Pogrebnyak, V. A. (Kharkov State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 1, 46-8(Jul 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 1, 64-6(Jan 1972).

The detection properties of a plasma in a high-frequency field are investigated. It is shown that the sign of the detection effect is determined by the electron momentum scattering. (auth)

42306 STATIONARY STATE OF A HIGH-CURRENT SELF-FOCUSING BEAM. Bonch-Osmolvskii, A. G.; Surovtsev, Yu. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 1, 1-5(Jul 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 1, 3-8(Jan 1972).

The possible existence of a stationary state for a cylindrical electron–ion beam is demonstrated for a dynamic model with self-consistent field; neutralization limits are determined. For $\nu/\gamma > 1$, where ν is the linear electron density and γ is the relativistic factor, the electron and ion densities are not proportional; furthermore, the electron component is nonuniform over the beam cross section, exhibiting hollow structure near the lower neutralization limit. (auth)

42307 ANOMALOUS PLASMA RESISTANCE DUE TO INSTABILITY AT CYCLOTRON HARMONICS. Galeev, A. A.; Lominadze, D. G.; Pataraya, A. D.; Sagdeev, R. Z.; Stepanov, K. N. (Inst. of High Temperature Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 15: No. 7, 294-6(5 Apr 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 7, 417-20(5 Apr 1972).

An expression is derived for the anomalous resistance that results from the buildup of Bernstein modes. The nonlinear mechanism that leads to saturation of the oscillation growth is discussed. The value of the anomalous resistance is obtained from the condition that the instability increment in the turbulent plasma should vanish. Electron scattering by oscillations with an unknown frequency is taken into account. (M.O.W.)

42308 DIFFERENCE SCHEME FOR VLASOV'S EQUATION. Nuehrenberg, Juergen (Univ. of Iowa, Iowa City). Z. Angew. Math. Phys.; 22: No. 6, 1057-76(25 Nov 1971).

A difference scheme is developed for the solution of the initial-value problem for the one-dimensional Vlasov equation for a collisionless electron plasma with a homogeneous ion background. Instead of the distribution function itself, its Fourier transform with respect to velocity is used. Case studies of nonlinear Landau damping, a stationary equilibrium, and a two-stream instability are presented as preliminary applications. (auth)

42309 NONLINEAR INTERACTION OF A SMALL COLD BEAM AND A PLASMA. PART II. O'Neil, T. M.; Winfrey, J. H. (Univ. of California, San Diego, La Jolla). Phys. Fluids; 15: No. 8, 1514-22(Aug 1972).

A single-wave model was previously used to construct a properly scaled universal solution for the initial nonlinear interaction between a small cold beam and a plasma. Two experimentally motivated extensions of the single-wave model are now related back to this universal solution. The first extension shows that, although the universal solution was originally obtained for boundary conditions where the wave grows temporally, it is, with proper scaling, equally valid for the more realistic boundary conditions in which the wave grows spatially from the point where the beam enters the plasma. The second extension concerns the statistical properties of the single-wave model. The universal solution is generalized so that it depends analytically on the initial phase and amplitude of the single wave, and the ensemble average of this generalized solution is then taken over all possible values of the initial phase and amplitude. This is a straightforward average of the solution over the initial conditions, and it does not rely on the random-phase approximation usually invoked in the theory of weak turbulence. The ensemble average corresponds to the typical experimental practice of time averaging the received signal, provided the ergodic theorem applies. (auth)

42310 CONSERVATION OF QUASIPARTICLES IN WEAKLY TURBULENT PLASMAS. Bloomberg, H. W. (Coll. of William and Mary, Williamsburg, Va.). Phys. Fluids; 15: No. 8, 1503-7 (Aug 1972).

An expansion making use of the eikonal is shown to yield a solution to the equations of a general weak turbulent plasma which is weakly dependent on space and time. The method is used to derive a quasi-particle conservation equation for quasi-static perturbations of Vlasov plasmas with general equilibrium field configurations. (auth)

42311 PROBABILISTIC MODEL OF PLASMA TURBULENCE. Benford, Gregory; Thomson, J. J. (Univ. of California, Irvine). Phys. Fluids; 15: No. 8, 1496-1502(Aug 1972).

To obtain convergent series in plasma turbulence theory, it is necessary to include the effects of the turbulent fields in the particle propagator. The assumptions and different approaches of previous workers, notably Dupree, Rudakov and Tsytovich, and Weinstock, are clarified. Their results may be obtained by a simple assumption: that particles in phase space diffuse in a Markovian way under the action of the stochastic turbulent fields. From statistical arguments similar to those of Weinstock, a quite general expression for the diffusion coefficient D(V) emerges. This result holds without assuming weak turbulence if the wave spectrum is sufficiently broad. From the Markovian view above there follows immediately, without involved calculation, the familiar expression for D(V) found by Dupree. Using probabilistic arguments, the particle propagator for a broad-band spectrum is calculated, allowing statistical spreading of trajectories in both position and velocity. This is identical to the usual method of obtaining a Green's function from a differential equation, but simpler. This new approach is valid whenever the turbulence is sufficiently broad-banded. (auth)

Production

Refer also to abstract 42259.

42312 ELECTROGASDYNAMIC JETS AS A SOURCE OF CHARGED PARTICLES. Vatazhin, A. B.; Likhter, V. A.; Shul'gin, V. I. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 5, 3-13(Sep-Oct 1971). (In Russian).

Theoretical and experimental investigations were conducted on submerged jets issuing from a source of charged particles (corona discharge). Laws similar to the distribution of electric parameters in a unipolar charged jet of gas were established in the case of grounded and insulated sources. Current from a grounded source is dependent upon the environment. A technique for decreasing the fusion potential was investigated. The distribution of local electrical parameters in the jet was measured by a probe method. The propagation of viscid unipolar charged jets and the formation of an electrical wind were considered. (tr-auth)

42313 PROPOSAL FOR OVERCOMING THE PLASMA MIRROR PROBLEM IN LASER INDUCED PLASMAS. Hughes, J. L. (Australian National Univ., Canberra). Search; 3: No. 5, 174-5(May 1972).

The effectiveness of laser systems in generating plasmas above 10^7 °C is seriously impaired by a "plasma mirror" at an electron density of about 10^{21} cm^{-3}. A system that prevents reflection of the pulse back into the laser system is described. A lens focuses the laser beam within several millimeters of the target without interfering with it, and a high-power reflector returns the pulse to a focus inside the target ionizing the pellet symmetrically and heating the resultant plasma to a very high temperature. The plasma cloud formed at the target expands to enclose the lens focal point within 10^{-9} to 10^{-8} s and acts as a shutter, effectively blocking any pulse returning from the reflector towards the laser system. (Australia)

Stability

42314 (ORNL-TM-3447) SIMULATION OF HIGH-FREQUENCY INSTABILITIES. Meier, H. K. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 27p. Dep. NTIS.

A method is developed for approximating a smooth distribution $f(\vec{x}, \vec{v})$ by a sum of Dirac delta functions $C \Sigma_j \delta(\vec{x}-\vec{x}_j(t))\ \delta(\vec{v}-\vec{v}_j(t))$. This method requires far fewer "particles" than the usual quiet starts used in plasma simulation. This will make it possible to run bigger problems at lower cost. This method is applied to studies of the nonlinear evolution of "double-hump" instabilities, expected to occur in Target Plasma experiments. Early results are given showing linear growth and its subsequent saturation in a weakly unstable plasma. This report emphasizes characteristics of the numerical methods; work now in progress seeks to exploit these methods to understand the physical mechanisms responsible for the nonlinear properties of gyro harmonic instabilities. (auth)

42315 PARAMETRIC INSTABILITIES IN A MAGNETIC FIELD AND POSSIBLE APPLICATIONS TO HEATING OF PLASMAS. Porkolab, M. (Prineton Univ., N. J.). Nucl. Fusion; 12: No. 3, 329-40(May 1972).

The dispersion relation for longitudinal plasma waves in the presence of an external high-frequency electric field is solved in terms of the dielectric function and its derivatives. Particular emphasis is placed on the case of short-wave-length ion acoustic waves ($\omega \gtrsim \omega_{pi}$), electron plasma waves ($\omega \gtrsim \omega_{ce}$), and cyclotron harmonic waves ($\omega_{ce} \gtreqqless \omega$), which propagate obliquely to the magnetic field. It is found that these modes are unstable with respect to: (i) the purely growing mode; (ii) the overstable acoustic mode; (iii) the dissipative-kinetic instability. The hot-plasma dispersion relation is solved numerically, and thresholds and growth rates are given for a large range of parameters. It is concluded that both the extraordinary mode and the whistler mode may be used to excite the foregoing instabilities, and thus may provide a means for enhanced heating of plasmas. Possible applications for heating of fusion plasmas are discussed. (auth)

42316 DIFFUSIVE TOROIDAL HYDROMAGNETIC EQUILIBRIA WITHOUT PS ENHANCEMENT. Nuehrenberg, J. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Nucl. Fusion; 12: No. 3, 383-5(May 1972).

Although the PS-factor has repeatedly been derived for a general hydromagnetic equilibrium, the question whether there exist toroidal equilibria without essential PS-enhancement has apparently received little attention. In the following, the Mercier–Maschke method is used to describe several classes of such equilibria. The relevant notations and formulae are given in the Appendix. Two limiting cases of stationary equilibria will be considered: those with vanishing toroidal current J(V), for which the stationarity is guaranteed by suitable material sources and those with non-vanishing toroidal $\oint \vec{E} \cdot d\vec{s}$ (and thus $J(V) \neq 0$) without material sources. (M.O.W.)

42317 ELECTROSTATIC INSTABILITIES DRIVEN BY CURRENTS PERPENDICULAR TO AN EXTERNAL MAGNETIC FIELD. Hirose, A. (Univ. of Saskatchewan, Saskatoon); Alexeff, I. Nucl. Fusion; 12: No. 3, 315-23(May 1972).

High-frequency ($\omega \gtrsim \omega_{ci}$) electrostatic instabilities driven by an electron–ion relative drift velocity across an external magnetic field are discussed for an inhomogeneous plasma. The presence of a density gradient perpendicular to the magnetic field was found to greatly reduce critical velocities for the onset of several instabilities such as lower hybrid oscillations and ion cyclotron harmonic waves. It was also shown that the lower hybrid instability can be caused by some positive dissipation mechanism such as Landau damping due to thermal ions and a finite electron collision rate. Some applications were made to turbulent heating experiments in plasmas in which cross-field currents are present. (auth)

42318 EXPERIMENTAL INDICATIONS OF PLASMA INSTABILITIES INDUCED BY LASER HEATING. Shearer, J. W.; Mead, S. W.; Petruzzi, J.; (and others) (Univ. of California, Livermore). Phys. Rev., A; 6: No. 2, 764-9(Aug 1972).

The detection of ~100-keV x radiation and of directly backscattered light is described for neodymium-glass-laser light pulses focused on a polyethylene target. These observations can be explained in terms of the nonlinear excitation of plasma waves by the laser light. (auth)

42319 INFLUENCE OF THE ELECTRON LARMOR RADIUS FINITENESS ON THE DEVELOPMENT OF HIGH-FREQUENCY FIREHOSE AND MIRROR INSTABILITIES. Egorenkov, V. D.; Stepanov, K. N. (Physical-Technical Inst., Kharkov. Physical-Technical Inst., Sukhumi, USSR). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 12, 1997-2001(Dec 1971). (In Russian).

It is shown that finiteness of the electron Larmor radius results in stabilization of short-wave oscillations (which are analogous to or are ion sound waves) in nonisothermal plasma with hot electrons and cold ions with the anisotropic electron velocity distribution in a frequency band of $\omega_{Hi} \ll \omega \ll \omega_{He}$, where ω_{Hi} and ω_{He} are ion-cyclotron and electron-cyclotron frequency, respectively. (auth)

42320 TWO-STREAM INSTABILITY IN THE MAGNETIC SLIT OF AN ELECTROMAGNETIC TRAP. Pankrat'ev, Yu. I.; Naboka, V. A.; Nozdrachev, M. G.; (and others). This paper was summarized in At. Energ. (USSR); 31: No. 3, 274-5(Sep 1971) as paper No. 531/6232. (In Russian).

Full copy of this paper is held by TIC.

One shortcoming of open magnetic traps which has to be considered is the loss of plasma along the lines of force of the magnetic field through the mirrors (magnetic slits) of the trap. These losses may be seriously restricted by successively reflecting ions, and later also electrons, within the trap. When the plasma potential in the trap is below the potential of the magnetic slits, only ions having an energy greater than the depth of the potential well will be able to climb out of the trap, and the electrons may be returned and confined by the electrostatic field of the electrodes situated along the magnetic slit, and holding them back. In that way, the level of plasma loss from the trap will be determined by the potential profile along the magnetic slit. The space charge of the electrons oscillating in the magnetic slit may reduce the potential barrier seen by the ions retained inside the trap. The "magnetized" secondary electrons formed when the gas is ionized are the most dangerous ones in that sense, because of their low velocity. Experimental verification has demonstrated, however, that the space charge of the electrons causes the electrons to move in the azimuthal direction along the surface of the magnetic slit. The drift velocity decreases toward the center of the magnetic slit, and this "slipping" of the stream leads to the development of the two-stream instability, which throws the electrons onto the wall of the magnetic trap. The characteristic frequency in this process must be the diocotron frequency $\omega \sim \rho_e/H \sim \Delta\varphi/Hr^2$, where ρ_e, $\Delta\varphi$, and r are respectively the density, potential, and transverse dimensions of the space charge in the magnetic field. The measured frequency of the first harmonic varied in inverse proportion to H and in direct proportion to the energy E of the beam of electrons injected into the trap, and generating the plasma by ionizing the residual gas. The frequency of oscillations was independent of the pressure, while the intensity of the oscillations increased with deterioration of the vacuum, because of the increased number of secondary electrons. As a result of these measurements, the density and potential of the space charge were estimated in the slits: $n \approx 10^8\ \text{cm}^{-3}$ and $\Delta\varphi \approx 50$ to 100 V. The nature of the diocotron (two-stream) instability is defined by the ratio $q \equiv \omega_p^2/\omega_c^2 = 4\pi\, n_e mc^2/H^2$, where ω_p and ω_c are the electron plasma frequency and the cyclotron frequency. When $q \ll 1$, long-wavelength modes of surface waves must develop. In the experiments, $q \approx 10^{-3}$ to 10^{-4}, and the characteristic frequencies lay in the range from 0.5 to 20 MHz. Two types of electrons exist in the trap: primary "hot" electrons from the cathode, used in order to accumulate plasma in the trap, and "cold" secondary electrons formed when the gas is ionized. The diocotron instability aids in removing secondary electrons from the trap, and makes it possible to replace these secondary electrons with fast electrons from the cathode of the electron gun. The fast electrons, because of their short time of flight through the slits, interact only slightly with the fields generated by the instability, and the plasma in the trap remains stable. Measurements of the ion distribution with respect to energies provides convincing evidence that ions with an equivalent temperature ≈250 eV and lifetime $\approx 10^{-2}$ sec are retained in the trap. (auth)

42321 h.f. INSTABILITY OF A FINITE PRESSURE PLASMA IN THE PRESENCE OF THE LOSS CONE. Kurchashov, Yu. P.; Chudin, N. V. (Inst. of Atomic Energy, Moscow). Plasma Phys.; 14: No. 2, 133-9(Feb 1972).

The stability is investigated of a homogeneous, collisionless finite pressure plasma with $\beta \gtrsim 1$ (β is ratio of the plasma pressure to that of the containing magnetic field). It is shown that in such a plasma with a non-monotonic distribution of transverse ion velocities, a high frequency instability develops on the whistler branch. The influence of Landau damping on the development of the instability is considered. It is shown that to stabilize the long wavelength perturbations, a much higher electron temperature is necessary than for short wavelength perturbations. (auth)

42322 INSTABILITY OF INHOMOGENEOUS PLASMA STREAMS. Zhelyazkov, I.; Rukhadze, A. A. (Lebedev Inst. of Physics, Moscow). Plasma Phys.; 14: No. 2, 167-88(Feb 1972).

The instability of plane-parallel plasma streams with a nonuniform velocity profile both with and without a longitudinal magnetic field is studied. Results for plasma streams are compared with those for the flow of an ideal conducting fluid: it is shown that although Rayleigh's theorem applies to the plane parallel case of instability in the ideal fluid, it does not in the present case. (auth)

42323 MAGNETOHYDRODYNAMIC EQUILIBRIA IN SHARPLY CURVED AXISYMMETRIC DEVICES. Callen, J. D. (Massachusetts Inst. of Tech., Cambridge. Oak Ridge National Lab., Tenn.); Dory, R. A. Phys. Fluids; 15: No. 8, 1523-8(Aug 1972).

Ideal magnetohydrodynamic equilibria in current-carrying diffuse toroidal pinches of circular cross section (tokamaks) are studied numerically to determine possible limitations on $\beta = 8\pi p/B^2$. Equilibrium considerations alone give no limitations even for $\beta \sim 1$ or $\beta_p \simeq \beta q^2 A^2 \sim A^2$, but the stability requirement $q > 1$ for magnetohydrodynamic kink modes does limit β. The best case found has $\beta \sim 0.1$ with $q > 1$, $A = 3$, and $\beta_p \sim 2$. (auth)

Thermonuclear Processes

Refer also to abstract 40753.

42324 (NP-19152) PROJECT FOR OBTAINING CONTROLLED NUCLEAR FUSION. A NEW SYSTEM THAT SHOULD LEAD TO RAPID PRACTICAL USE FOR ENERGY PRODUCTION BY CONTROLLED NUCLEAR FUSION. Nowak, K. [nd]. 16p. (In German). Dep. NTIS (U. S. Sales Only).

The method described should make possible the technical evaluation of controlled nuclear fusion with positive energy balance and high efficiency for the energy production and, by creation of defined ratios, avoid the origin of neutron or tritium emission. For this method, the brief collision of plasmas of high ion density formed from accelerated deuterium ions and electrons was proposed. The selected pulse times and accelerations permits the greatest possible efficiency of the fusion process. The bias against obtaining controlled nuclear fusion by collision of accelerated ions was based on the previous ratios for pure ion beams of usual plasma densities, but is erroneous for plasma beams of high density. (tr-auth)

42325 (ORNL-TM-3880) EFFECTS OF MAGNETIC FIELD ERRORS IN ORMAK. Rome, James A. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 22p. Dep. NTIS.

The effect of errors in the magnetic field of ORMAK arising from the leads of the toroidal field coils is calculated. It is found that in the first few milliseconds of a discharge, these errors may open the flux surfaces if the heating current and toroidal field are parallel. This opening of flux surfaces may account for the observed elimination of runaway electrons in ORMAK. At later times in the discharge the effect of these field errors is negligible. (auth)

42326 PLASMA INJECTORS WITH CAPACITY AND INDUCTANCE ENERGY STORAGE. Belan, N. V.; Mashtylev, N. A.; Panachevnyi, B. I. (Kharkov Aviation Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1642-5(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2073-8(Oct 1971).

The acceleration of a plasmoid in an injector with capacity and inductance energy storage is treated. A system of equations is derived and solved numerically for capacity and inductance energy storage. The conditions under which an injector provides the same efficiency, regardless of the type of energy storage, are determined. (auth)

42327 TOKAMAK APPROACH IN FUSION RESEARCH. Coppi, Bruno; Rem, Jan (Massachusetts Inst. of Tech., Cambridge). Sci. Amer.; 227: No. 1, 65-75(Jul 1972).

The basics of a tokamak device are discussed. The various combining magnetic fields are described along with the kink instability and banana regime. A variety of tokamak experiments throughout the world are briefly described. (M.O.W.)

42328 OPTIMIZED MAGNETIC FIELD PROFILES AND A β-LIMITATION IN MINIMUM-B MIRROR REACTORS. Cordey, J. G.; Watson, C. J. H. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nucl. Fusion; 12: No. 3, 287-96(May 1972).

The steady-state collisional distribution function of a mirror-confined plasma which is known from Fokker–Planck calculations implies a unique relationship between the plasma pressure and the magnetic field strength at any point within the plasma. Using this relationship, it is possible to deduce the maximum β consistent with macroscopic stability in a mirror machine with given mirror ratio. This β limitation is found to impose a rather mild restriction upon reactor designs. For fields which satisfy this β limitation, the profile of the magnetic field along its axis is restricted but not fully determined, by the minimum-B requirement, and the remaining freedom can be used to optimize the magnet design by maximizing the ratio of the thermonuclear power produced to the cost of the magnetic field windings. It is found that even when the profile has been optimized in this way, the plasma density and pressure profiles are rather peaked towards the center of the reactor, and the ratio of the thermonuclear power produced in such an optimized minimum-B reactor to the power which would be produced in a reactor of the same dimensions but with a square well profile (if it were stable) is approximately ¼. (auth)

42329 WALL EROSION IN A FUSION REACTOR DUE TO SPUTTERING. Vernickel, H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Nucl. Fusion; 12: No. 3, 386 (May 1972).

It is suggested that wall erosion should be regarded as a function of the power transmitted by particle bombardment to the wall per unit area, rather than that the total fuel throughout be taken as a measure of wall bombardment. Some earlier sputtering data of niobium by light ions are discussed. (M.O.W.)

42330 TORSATRON WITHOUT TOROIDAL FIELD COILS. II. CONFIGURATION l equals 2. Marty, D.; Maschke, E. K.; Touche, J.; Gourdon, C. (CEN, Fontenay-aux-Roses, France). Nucl. Fusion; 12: No. 3, 367-72(May 1972).

As a continuation of a previous study, the magnetic configuration of the torsatron with $l = 2$ helical windings and no toroidal field coils is investigated. A useful volume with closed toroidal magnetic surfaces exists only for sufficiently large pitch angles of the helical windings (>45°). With increasing pitch angle the rotational transform on the magnetic axis decreases, and high shear is obtained ($\Theta \sim 1$). In this case, the mirror ratio along the field lines is relatively high ($B_{max}/B_{min} > 1.5$). If one requires low mirror ratio ($B_{max}/B_{min} < 1.5$), the $l = 2$ configuration is limited to low shear, in contrast to the previously studied case $l = 3$ which has considerable shear even when the mirror ratio is low. (auth)

42331 NEUTRONIC CALCULATIONS FOR A FUSION-REACTOR–BLANKET ASSEMBLY BY DISCRETE ORDINATES AND MONTE CARLO METHODS. Brockmann, H. (Kernforschungsanlage, Juelich, Ger.). Nucl. Fusion; 12: No. 3, 389-91(May 1972).

Neutron fluxes and reaction rates were determined by using the transport codes ANISN and MORSE. ANISN is a one-dimensional multigroup discrete-ordinates transport code with anisotropic scattering. MORSE is a transport code based on the Monte Carlo method which can employ the same cross-section data sets as ANISN. A comparison of the calculations is given in tabular form. (M.O.W.)

42332 SKIN EFFECT IN LARGE TOKAMAKS. Duechs, D. F.; Furth, H. P.; Rutherford, P. H. (Princeton Univ., N. J.). Nucl. Fusion; 12: No. 3, 341-4(May 1972).

Computer studies based on the empirical transport coefficients of present-day tokamaks predict strong skin effect in larger, hotter tokamak models. If the skin effect is suppressed by further anomalous enhancement of thermal transport in the skin layer, the resultant energy loss and associated limiter heat load are inevitably very large. Suppression of the skin effect by a moving limiter is investigated. (auth)

42333 INITIATION OF THERMONUCLEAR REACTIONS BY HIGH-CURRENT ELECTRON BEAMS. Winterberg, F. (Univ. of Nevada, Las Vegas). Nucl. Fusion; 12: No. 3, 353-62(May 1972).

It has been shown previously that the ignition of thermonuclear micro-explosions (micro-bombs) may become possible by bombarding a dense thermonuclear target with an intense relativistic electron beam. Although such a scheme is within the realm of technical feasibility, the energy requirements were shown to be considerable, amounting to a burst of relativistic electrons of several megajoules to be delivered within several nanoseconds. It is shown that the energy requirements can be greatly reduced by utilizing the strong self-magnetic field of intense electron beams. The strong self-magnetic field can reduce the electronic-heat-conduction losses and also greatly quench the range of the charged fusion products within the thermonuclear target. The reduction in the input energy in conjunction with the demand for a strong self-magnetic beam field directs the emphasis on beams of relatively low voltage but high current. The relatively low beam voltage also facilitates the beam energy dissipation in the target.

Because of the much greater ease and efficiency by which intense electron beams can be produced as compared to laser beams and because of the energy-reducing effect of the self-magnetic beam field the described method may have substantial advantages over the laser method of bombarding a thermonuclear target. (auth)

42334 EFFECT OF TAIL CHOPPING OF THE MAXWELL ION VELOCITY DISTRIBUTION ON THE YIELD OF FUSION REACTIONS IN A PLASMA. **Bazhanova, A. E.; Kogan, V. I. At. Energ. (USSR); 32: No. 5, 440-1(May 1972). (In Russian).**

The intensity of thermonuclear reactions occurring in a plasma at a temperature of hundreds of electronvolts depends on the shape of the deuteron distribution function in its tail portion, where it may drop off both faster or more slowly than the typical Maxwellian. The estimation of ion temperature by the measured yield of thermonuclear reactions is discussed. The distribution parameters are compared with a Maxwell distribution. Calculated intensities or (yields) of reactions at temperatures from 200 to 1,000 eV are tabulated for the "approved" Maxwellian ion energy distribution, which are about half of the values for a "complete" Maxwell distribution. (K.S.W.)

42335 FORMATION OF HIGH-FREQUENCY FIELDS IN R-0 AND RT-2 TOROIDAL TRAPS. **Zverev, G. I.; Burdiashvili, M. Sh.; Lyul'ev, V. L.; (and others). This paper was summarized in At. Energ. (USSR); 31: No. 3, 273(Sep 1971) as paper No. 529/6004. (In Russian).**

Full copy of this paper is held by TIC.

Various experiments carried out in the R-0 and RT-2 installations have used zeroth-mode high-frequency fields (cophasal-current fields) or rotating quadrupole magnetic fields. These fields are produced by means of highly coupled LC circuits whose inductances are formed by equal-length rods spaced uniformly around the discharge chamber, enveloping it and forming a helix. An electrically symmetric winding is thus produced. Eight-rod windings are used in the R-0 and RT-2 installations. The fields produced by such a winding differ from the "ideal" fields which may be produced by a cosinusoidal current. A calculation shows that the deviation of the fields in the R-0 and RT-2 from the "ideal" fields at the surface of the discharge chamber is 40%. The field distortion arising because of the gaps at the points where the current is supplied to the winding rods is 15%. The eight rods in the winding produce a quadrupole magnetic field rotating around the chamber axis. Here the currents in neighboring rods are shifted by a phase of $\pi/2$. This current distribution corresponds to one of the resonant frequencies of this oscillation system. Five oscillation modes may be excited in the eight-rod system. In order to excite the circuit in only the selected mode, circuit points which are cophasal for the given mode are short-circuited, and the supply oscillators are operated in a suitable phase relationship. This results in the simultaneous excitation of a rotating quadrupole field and a zeroth-mode field. A paraphase oscillator is used to excite the zeroth mode, while the second mode is excited by a four-phase oscillator. The rods are divided into parts to increase the field intensity, and capacitors are distributed around the circuit. The R-0 and RT-2 operate in a quasisteady state. The pulse length is 0.5 to 3 msec, the pulse repetition frequency is 0.05 to 0.1 Hz, and the range of working frequencies is 0.1 to 5 MHz. The high-frequency field reached in a volume of 10 to 20 liters at a radial distance of 0.7 of the circuit radius is 800 to 1000 Oe at 0.5 MHz (R-0) and 200 to 300 Oe at 2.3 MHz (RT-2). In both cases, the field level is limited by the working voltage used in the oscillatory system of capacitors. (auth)

42336 STRUCTURES OF MAGNETIC SURFACES OF VARIOUS SYSTEMS WITH SPATIALLY PERIODIC MAGNETIC FIELD. **Loktionov, Yu. M.; Sebko, V. P.; Tyupa, V. I. This paper was summarized in At. Energ. (USSR); 31: No. 1, 52-3 (Jul 1971) as paper No. 508/5980. (In Russian).**

Full copy of this paper is held by TIC.

An experimental investigation was made of the structures of magnetic surfaces in spatially periodic systems. The procedure used in the present article for annular electron beams makes it possible to gain a general concept of configurations of the magnetic field characterizing the systems in question. Possible combinations of magnetic fields formed with the aid of a helical coil consisting of two conductors (with current I flowing through each of them) combined with a solenoid of longitudinal magnetic field H_0 and a rod carrying current J along the geometric axis of the system were investigated. The following configurations were studied experimentally: a unifilar vintotron (helitron) ($n = 1$); unifilar and bifilar vintotorus (helitorus) of the first kind ($l = 1$, $l = 2$); unifilar and bifilar helitorus of the second kind ($m = 1$, $m = 2$); a system with currents of different absolute magnitude flowing through helical conductors. Some typical patterns of the electron beam displayed on a fluorescent screen are shown for the $n = 1$ and $l = 2$ configurations. Photographs of this type were obtained for all the basic modes of fields enumerated above. In addition to the annular electron beam procedure, the described work relied on probing of magnetic fields by a point electron beam, so as to determine the extent of crossing of the magnetic lines of force (shear). The experimentally measured shear attained values from 0.06 to 0.18 under optimum conditions for the systems investigated. The calculated depth of the magnetic well was 2 to 4.8%. (auth)

42337 MAGNETIC COMPRESSION OF ASTRON-TYPE E LAYERS. Schmidt, George (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Fluids; 15: No. 8, 1540-1(Aug 1972).

The compression of a simplified model of an E layer by a rising confining field is investigated. A formula is obtained for particle energy as a function of the confining field, and it is shown that field reversal decreases with compression. (auth)

Wave Phenomena

42338 DENSITY STEP PRODUCTION OF LARGE-AMPLITUDE COLLISIONLESS ELECTROSTATIC SHOCKS AND SOLITONS. Cohn, David Bertram. Los Angeles; Univ. of California (1971). 89p. University Microfilms Order No. 72-2791. Thesis.

Large-amplitude shocks and solitons are produced by instantaneous density steps obtained through the superposition of a photoionized plasma on a dc background. The dc plasma is maintained by an extended array of emissive filaments, while the photoplasma spatial step is obtained by the collimation of a burst of photons from a vacuum spark (of two ion plasma periods duration). For collimations of 20-cm (400 λ_{De}) width, shocks are produced; whereas, 5-mm (10 λ_{De}) widths produce solitons. In both cases, the initially symmetric plasma slab develops into disturbances symmetric about the original slab center, propagating in opposite directions. For $1.5 \leq R \leq 20$ (where $R = n_1/n_2$; n_1 = step density; n_2 = background density) the Mach number, M, for both shocks and solitons increases up to a maximum of $M \simeq 2.5$, for $R = 20$ (the maximum value of R attainable). The shock front width decreases with increasing R up to $R \simeq 5$ ($M \simeq 1.6$); and the shock profiles are steady in character over their trajectories. For $R \gtrsim 5$, however, the profiles broaden severely in space. Coincident with this transition from a steady to a diffuse form is the loss of dispersion-generated wavelets. Solitons are found to exhibit this same behavior. Furthermore, both shocks and solitons are found to pass through the "critical Mach number" without any change in structure. Qualitative agreement is obtained (except for a very striking initial overshoot) between the experimental results and the cold ion isothermal electron model developed by Moiseev Sagdeev, up to the limit where their analysis is valid ($M \simeq 1.6$). In this region and also for higher Mach number flows, the results are compared with those from the computer calculations by Mason and by Sakanaka, et al., the agreement is found to be good. Soliton interactions are also observed up to $M \simeq 1.8$ for the two cases of solitons catching up and colliding head on. In both instances, the interactions are reversible, thereby extending the predictions of the weakly nonlinear theory to the highly nonlinear regime. (Diss. Abstr. Int., B)

42339 SPECTRUM OF NATURAL OSCILLATIONS OF A PLASMA COLUMN IN TOKAMAK TO-1. **Ivanov, N. V.; Kovan, I. A.; Los, E. V. At. Energ. (USSR); 32: No. 5, 389-93(May 1972). (In Russian).**

The Q of the plasma, determined by the width of the spectral lines, reached a value of 250. It was established that the absorption of excited oscillations is not due to collisions. It was shown that a transfer of rf energy to the plasma is possible when generating a selected mode using feedback, and also in the dense portion of the spectrum from a fixed-frequency generator. (5 figures, 13 references) (auth)

42340 NONLINEAR THEORY OF ELECTROMAGNETIC WAVE PROPAGATION IN PLASMA NEAR HYBRID RESONANCES. **Pokroev, A. G.; Stepanov, K. N. (Kharkov State Univ. Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 10, 1658-63(Oct 1971). (In Russian).**

The distribution of the amplitude of an electromagnetic wave with a frequency close to one of the hybrid resonance frequencies is investigated for a magnetoactive plasma. The high-frequency potential of the wave producing a redistribution of electrons and ions and spatial dispersion of the plasma, caused by thermal motion of the electrons, is taken into account. (auth)

42341 EXCITATION OF ELECTRON-CYCLOTRON WAVES BY A MODULATED HELICAL ELECTRON BEAM. **Bashko,**

V. A.; Zalesskii, Yu. G.; Nazarov, N. I. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1717-20 (May 1972). (In Russian).

The interaction between a helical, transverse speed-modulated electron beam and a plasma is investigated. It is shown that the beam efficiently excites electron-cyclotron waves at the modulation frequency. The intensity of the electron-cyclotron oscillations exceeds that of the oscillations without modulation of the electron beam by more than 10^3 times. It is also demonstrated that the main source of the oscillation energy is the energy of the electron beam. (auth)

42342 EXCITATION OF LONGITUDINAL OSCILLATIONS IN MAGNETOACTIVE PLASMA BY MONOENERGETIC ELECTRON COMPONENT. Kaladze, T. D.; Stepanov, K. N. (Tbilisi State Univ., USSR. Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 10, 1631-7(Oct 1971). (In Russian).

Excitation of longitudinal plasma oscillations in a magnetic field by a group of low density, fast monoenergetic electrons is investigated. If the angle Θ between the wave vector and magnetic field is not too close to $\pi/2$, the oscillations are excited by resonant electrons and have the growth rate $(n_0'/n_0)\omega$, (n_0' is the density of fast electrons, and n_0 of cold ones). If the angle Θ is equal to $\pi/2$, the coherent excitation is possible when the resonance condition $n\omega_H = \sqrt{\omega^2 p + \omega_H^2}$ is satisfied ($n = 2, 3, \ldots$). In this case, the growth rate is equal to $\gamma \sim (\sqrt{n_0'/n_0})\omega$. It is marked that the instability considered may be the cause of the superthermal emission from a discharge with oscillating electrons. (auth)

42343 INVESTIGATION OF THE OSCILLATIONS OF A NONEQUILIBRIUM LOW-DENSITY PLASMA IN A MAGNETIC FIELD. Golubev, V. S.; Lebedev, F. V. (Inst. of Atomic Energy, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 6, 1026-30(Nov-Dec 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 6, 1113-18(Nov-Dec 1971).

Experimental results are presented of an investigation of the stability of a nonequilibrium He−Cs plasma having a low electron concentration ($n_e \sim (10^{12}-10^{13})$ cm^{-3}) in a magnetic field. It was established that depending on the degree of ionization of the impurity and on the magnitude of the magnetic field, three oscillation modes develop in the plasma. The values of the critical magnetic field are presented, as well as the values of the development times of the various oscillation modes. The results of the experiment are compared with the results of the theoretical calculations of plasma stability relative to ionization oscillations, carried out with allowance for the finite recombination rate. Agreement between the theory and the characteristics of one of the oscillation modes was observed. (auth)

42344 ULTRA-HIGH FREQUENCY DRIFT WAVES. Detyna, E.; Wooding, E. R. (London Univ.). Plasma Phys.; 14: No. 2, 97-101(Feb 1972).

A dispersion relation is produced for ultra-high frequency drift waves arising from an electron stream drifting through a density gradient in a plasma. Plasma stability is discussed. (auth)

42345 CROSSOVER FREQUENCIES IN PLASMAS WITH TWO SPECIES IN THE PRESENCE OF THE CORIOLIS FORCE. Uberoi, C.; Das, G. C. (Indian Inst. of Science, Bangalore). Plasma Phys.; 14: No. 2, 201-2(Feb 1972).

It is shown that in the presence of the Coriolis force crossover frequencies, characteristic features of plasmas consisting of two or more species can exist in plasmas of only two species. The significance of this in relation to explanations of proton whistlers is examined. (UK)

42346 COLLAPSE OF LANGMUIR WAVES. Zakharov, V. E. (Novosibirsk State Univ., USSR). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1745-59(May 1972). (In Russian).

It is shown that arbitrary Langmuir turbulency of sufficient intensity ($W/nT > (kr_D)^2$) is unstable. The instability leads to the development of significantly nonlinear phenomena viz. the formation of low density regions (caverns) in the plasma which collapse during a finite time. Cavern collapse is an effective mechanism of energy dissipation of longwave Langmuir oscillations and plays an important role in the kinetics of Langmuir turbulency. The problem of the nonlinear stage of instability development of a monochromatic Langmuir wave is also considered. (auth)

42347 NONLINEAR ION SOUND IN A COMPLETELY IONIZED CURRENT-CARRYING PLASMA. Al'terkop, V. A. (Inst. of High Temperatures, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1760-3(May 1972). (In Russian).

Under conditions of applicability of the hydrodynamic approximation, a nonlinear equation in partial derivatives is obtained which describes the time development of ion-sound instability in a completely ionized plasma with a current. A stationary solution of the equation is obtained near the stability threshold. The characteristics of a stationary ion-sound wave at both low and high supercriticalities of the system are determined. (auth)

42348 INSTABILITY OF SUPRA-LUMINOUS WAVES IN WEAKLY TURBULENT PLASMAS. Lerche, I. (Univ. of Chicago). Plasma Phys.; 14: No. 2, 189-99(Feb 1972).

Within the framework of the linearized Vlasov equation it is demonstrated that supra-luminous waves in a one-dimensional plasma, which would freely propagate in an infinite homogeneous system, are influenced by turbulent functions in the background ion density. In general, it is demonstrated that the supra-luminous waves no longer freely propagate but either damp or grow. In the particular situation where the plasma is ultra-relativistic it is shown that any one supra-luminous mode bifurcates under the influence of the turbulent fluctuations into two modes, one growing, one decaying, both with the same e-folding time. This particular situation illustrates, by direct computation, the basic point that within the framework of the linearized Vlasov−Maxwell equations a turbulent plasma mechanism exists for energy gain (and loss) of supra-luminous waves. (auth)

42349 NONLINEAR WAVE MODULATION IN COLLISIONLESS PLASMAS. Ichikawa, Yoshi H. (Nihon Univ., Tokyo); Imamura, Tsutomu; Taniuti, Tosiya. J. Phys. Soc. Jap.; 33: No. 1, 189-97(Jul 1972).

The reductive perturbation method is applied to the Vlasov equation which governs the one-dimensional motion of collisionless plasmas. The present formulation makes it possible to investigate the nonlinear modulation of the plasma waves with an arbitrary dispersion. Structures of the resulting nonlinear Schroedinger equation were studied explicitly for the electron plasma wave and for the ion plasma wave. (auth)

42350 PARAMETRIC EXCITATION OF BERNSTEIN WAVES IN INHOMOGENEOUS MAGNETO-PLASMAS. Sugaya, Reiji (Kyoto Univ.). J. Phys. Soc. Jap.; 33: No. 1, 183-8(Jul 1972).

Experimental studies of the parametric excitation of Bernstein waves in inhomogeneous plasmas were made. The threshold becomes minimum near the double resonance where the upper hybrid frequency f_h equals twice the electron cyclotron frequency $2f_c$ ($f_h = 2f_c$) and depends on the density gradient of the inhomogeneous plasma. The experimental results can be interpreted by the theory in which the electromagnetic wave excites the Bernstein waves parametrically via the density gradient. (auth)

42351 LANDAU DAMPING IN DEGENERATE SOLID STATE PLASMAS. Halevi, P. (McGill Univ., Montreal). Solid State Commun.; 10: No. 12, 1189-93(15 Jun 1972).

Helicon waves are found useful for studying Landau damping in degenerate plasmas. The damping is analyzed as the phase velocity of the wave is increased from $\omega/q \ll v_F$ to $\omega/q \gg v_F$. There is no first-orderlike transition at $\omega/q = v_F$. In the collisionless limit, the damping tends to zero as $\omega/q \to v_F$. For finite collision times τ it does not vanish for $\omega/q > v_F$. Nonlocal corrections to the wavelength exhibit a peak at $\omega/q = v_F$, which degenerates into a shoulder for $\omega\tau \lesssim 100$. (auth)

42352 ASYMPTOTIC METHOD FOR THE VLASOV EQUATION. III. TRANSITION FROM AMPLITUDE OSCILLATION TO LINEAR LANDAU DAMPING. Sugihara, Ryo; Kamimura, Tetsuo (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 33: No. 1, 206-15(Jul 1972).

The nonlinear behavior of Landau damping is investigated numerically. The basic equations are able to describe the amplitude oscillation, linear Landau damping, and intermediate regions of wave behavior. If $q \equiv \gamma_L/\omega_B$, where γ_L is the linear Landau damping coefficient and ω_B the bouncing frequency of electrons trapped in the wave, one finds that for $q \ll 1$, a plateau is formed in the time dependence of the amplitude of the electric field D, while for $q \lesssim 0.5$ a plateau may also be formed. Another kind of plateau appears for $q \approx 0.77$, but for $q < 0.77$ the wave is damped (not necessarily Landau damped). The time evolution of the number of "trapped" electrons and also of the distribution of resonant electrons is obtained. It is found that even when D reaches its constant asymptotically for $q \ll 1$ the corresponding distribution of resonant electrons is not necessarily uniform in the trapped regions. (auth)

42353 PULSE DISTORTION BY ANISOTROPIC PLASMAS. Bachynski, M. P.; Gibbs, B. W. (RCA Research Labs., Montreal). Can. J. Phys.; 50: No. 11, 1221-3(1 Jun 1972).

Experimental measurements of electromagnetic pulses transmitted through a plasma under conditions of strong interaction (strong heating of the electrons) between the incident wave and the plasma were performed. Severe pulse distortion, depending on the plasma density and pulse shape, can occur. The leading edge of the pulse does not always show maximum penetration through the plasma. (auth) (Canada)

42354 STRONG-FIELD ELECTROMAGNETIC WAVE INTERACTION WITH ANISOTROPIC PLASMAS. Bachynski, M. P.; Gibbs, B. W. (RCA Research Labs., Ste. Anne de Bellevue, Quebec). Can. J. Phys.; 50: No. 8, 826-42(15 Apr 1972).

Investigations of strong-field electromagnetic wave interactions with plasmas were conducted. In the nonresonant frequency regions, the electron velocity distribution function is Maxwellian and considerations based on Maxwellian theory agree with experiment. At resonant and near-resonant frequencies considerations based on an electron velocity distribution which is non-Maxwellian explain the observations if enhanced electron diffusion is absent. However, at near-resonant frequencies, enhanced electron diffusion due to strong fields can be of great significance in reducing the electron density. (auth)

42355 EFFECTS OF LANDAU DAMPING ON NONLINEAR WAVE MODULATION IN PLASMA. Sanuki, Heiji; Shimizu, Katsuya; Todoroki, Jiro (Nihon Univ., Tokyo). J. Phys. Soc. Jap.; 33: No. 1, 198-205(Jul 1972).

On the basis of the Vlasov equation, an equation to describe behavior of the electric potential for small- but finite-amplitude waves in a plasma is obtained. Under a certain stretching scheme, the equation is reduced to the generalized nonlinear Schroedinger equation $i(\partial\psi/\partial\zeta) + \alpha(\partial^2\psi/\partial\eta^2) + \beta|\psi|^2\psi + i\gamma\psi = 0$, where α and β are constants ($\alpha\beta < 0$) and γ means the damping constant. The decay process of the nonlinear electron plasma wave is investigated on the basis of this equation. It is found that the soliton can exist for a finite time interval and, under a certain condition, the amplitude of the soliton grows first and then damps away. (auth)

42356 EXCITATION OF ALFVEN WAVES IN A HIGH-β PLASMA. Fridman, A. M. (Novosibirsk State Univ., USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 1, 23-9(Jul 1972). Translated from Zh. Tekh. Fiz.; 42: No. 1, 33-41(Jan 1972).

The stability of an inhomogeneous high-pressure plasma against Alfven waves is analyzed. The growth rates are found and the instability limits are determined for both the wavelength and the ratio of the magnetic field gradient to the temperature gradient, $T\Delta B/B\Delta T$. In particular, it is shown that the hydrodynamic instability is stabilized for $|T\Delta B/B\Delta T| > 1/4$ and the kinetic instability is stabilized for $T\Delta B/B\Delta T < -2/$ (auth)

42357 EFFECTS OF COLLISIONS ON PERPENDICULAR LONGITUDINAL ION WAVE PROPAGATION IN A MAGNETIZED PLASMA. Berry, L. A.; Nickel, J. C. (Univ. of California, Riverside). Phys. Fluids; 15: No. 8, 1473-6(Aug 1972).

The effect of ion–ion and ion–neutral collisions on longitudinal ion waves propagating perpendicular to a magnetic field was calculated. Ion–neutral collisions are incorporated into the Vlasov calculation via a BGK collision term while the ion–ion collision portion of the calculation is based on a model Fokker–Planck equation. It is shown that the effect of both types of collisions is to cause the dispersion relations to become more fluid-like. For quite modest values of the ion–ion collision frequency ($v_{ii}/\omega_{ci} \sim 0.1$), the dispersion relations are essentially those predicted by the moment equations. (auth)

42358 STRUCTURE OF ION ACOUSTIC SOLITONS AND SHOCK WAVES IN A TWO-COMPONENT PLASMA. White, Roscoe B.; Fried, Burton D.; Coroniti, Ferdinand V. (Univ. of California, Los Angeles). Phys. Fluids; 15: No. 8, 1484-90(Aug 1972).

Time-independent solitary waves and shocks are investigated in a two-component plasma using a fluid model and kinetic theory. It is found that very small concentrations of a light ion can drastically alter the structure, changing the potential maximum ϕ_m by an order of magnitude. For a fixed Mach number, a critical density ratio of light to heavy ions is found at which ϕ_m changes discontinuously from a value large enough to reflect the light ions to one which allows them to traverse the shock front and enter the downstream flow. The downstream oscillatory structure normally seen in a shock is completely quenched by dissipation due to light ion reflection at concentrations of 3 to 8% He in an Ar plasma for typical T_e/T_i and Mach number values. (auth)

42359 SOLITARY WAVES IN A TWO-ION BEAM, MAGNETIZED PLASMA. Goldenbaum, G. C.; Gerber, K. A.; Levine, L. S.; Krall, N. A. (Naval Research Lab., Washington, D. C.). Phys. Fluids; 15: No. 8, 1491-5(Aug 1972).

Experimental evidence and a theory are presented for the properties of solitary waves that propagate at right angles to a magnetic field in a plasma that contains two classes of ions with a relative drift velocity between them. Two kinds of nonlinear wave motion are seen to exist. One type of wave reduces to the magnetosonic solitary wave as the density of one of the ion components becomes small. The other type of solitary wave appears to be an ion beam wave. For example, if one of the ion components is at rest in the laboratory, the wave velocity approaches a value less than the moving ion velocity. Unlike the magnetosonic solitary wave, these waves can have velocities much greater than twice the Alfvén speed. (auth)

42360 NONLINEAR THEORY OF DENSITY FLUCTUATIONS IN TURBULENT PLASMAS. Sleeper, Arthur M.; Weinstock, Jerome (National Oceanic and Atmospheric Administration, Boulder, Colo.). Phys. Fluids; 15: No. 8, 1507-14(Aug 1972).

The level of rms density fluctuations in a turbulent plasma, saturated by modified particle orbits, is theoretically found to obey a remarkably general, but simple, formula. The results are obtained independently of the form of the dispersion relation and are therefore applicable to turbulence arising from a broad class of instabilities. The restrictions on the ratios between gyro, collision, and mode frequencies are explicitly given. Both the collisional and collisionless cases are discussed, and shown to be consistent with a variety of experiments. (auth)

42361 WEAK INHOMOGENEITY FORMALISM AS APPLIED TO THE BERNSTEIN MODES. Tang, Ting-wei; Sivasubramanian, A. (Univ. of Massachusetts, Amherst). Phys. Fluids; 15: No. 8, 1534-6(Aug 1972).

Bernstein modes propagating in the direction of the number density gradient are studied. The resulting field equation is compared with that found from an exact integral equation obtained by Fourier-transform techniques. The weak inhomogeneity formalism is shown to be accurate only to the order λ/L. (auth)

42362 ASYMPTOTIC SOLUTION OF LANDAU'S DISPERSION EQUATION. Canosa, Jose (IBM Scientific Center, Palo Alto, Calif.). Phys. Fluids; 15: No. 8, 1536-7(Aug 1972).

The asymptotic solution of Landau's dispersion equation valid for long wavelengths is obtained analytically to an arbitrary order of accuracy, thus improving Landau's first-order solution and Jackson's second-order solution. (auth)

42363 SIMULATION OF WHISTLER INSTABILITIES IN ANISOTROPIC PLASMAS. Ossakow, S. L.; Haber, I.; Ott, E. (Naval Research Lab., Washington, D. C.). Phys. Fluids; 15: No. 8, 1538-40(Aug 1972).

Computer simulations are used to study whistler turbulence in plasmas driven by initially anisotropic bi-Maxwellian and loss-cone electron distributions. Linear growth saturates when the growth rate is of the order of the particle trapping frequency. (auth)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstract 40936.

42364 (AERE-R-7072) FORTRAN PROGRAM TO CALCULATE ENERGY LOSS OF CHARGED PARTICLES. McNaughton, M. W. (Atomic Energy Research Establishment, Harwell (England)). Mar 1972. 13p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

A FORTRAN-4 program is described to calculate the energy loss, range, and time of flight of charged particles, losing energy by ionization in passing through a series of adjacent materials. The calculation of energy loss uses a theoretically based formula, which may be taken without modification, or adjusted to improve the fit to existing data. Range and time of flight are obtained by integration of this formula. A complete listing of the program, incorporating a number of useful facilities, is included. (auth)

42365 (CONF-701138) PROCEEDINGS OF THE NATIONAL SYMPOSIUM ON RADIATION PHYSICS, BOMBAY, NOVEMBER 24–27, 1970. (Bhabha Atomic Research Centre, Bombay (India). Electronics Board). 1971. 660p.

Fifty-seven papers are included. Separate abstracts were prepared for forty-nine. (M.H.R.)

For abstracts of individual papers see: 40691, 40692, 40824, 40827, 40828, 40839–40842, 40849, 40852, 40856, 40857, 40865, 40897–40906, 40925–40931, 40943, 40944, 40979, 41312, 41494, 41504, 41724, 42103, 42104, 42377–42379, 42384, 42391, 42443, 42553, 42588, and 42589.

42366 (CONF-720408-1) INTERMEDIATE PHASE STUDIES FOR UNDERSTANDING RADIATION INTERACTION WITH CONDENSED MEDIA: THE ELECTRON ATTACHMENT PROCESS. Christophorou, L. G. (Oak Ridge National Lab., Tenn. Tennessee Univ., Knoxville. Dept. of Physics). [1971]. 19p. Dep. NTIS.

From Conference on elementary processes in radiation chemistry; Notre Dame, In. (4 Apr 1972).

The conclusions reached in a previously reported study in which gaseous data on electron attachment were related to hydrated-electron–molecule reaction rates are summarized briefly. Preliminary information on electron attachment to molecules in very high pressure gases is reported. Rates of electron attachment to O_2 in mixtures of O_2 and N_2 are plotted as a function of the mean electron energy for O_2 pressures $P_{O_2} \rightarrow 0$ and for N_2 pressures of 300 to 10,000 torr. The attachment rates are seen to increase constantly with increasing P_{N_2}. For each P_{N_2} the maximum value of the attachment rate is attained at a mean electron energy of about 0.05 eV. Structure in the cross sections obtained from these data and possible attachment mechanisms are discussed. (A.G.W.)

42367 (CONF-720607-8) COUPLED NEUTRON AND GAMMA RAY MULTIGROUP CROSS SECTION LIBRARY FOR USE IN SHIELDING CALCULATIONS. Morrison, G. W. (Oak Ridge National Lab., Tenn.); Straker, E. A. (Science Applications, Inc., Huntsville, Ala. (USA)); Odegaarden, R. H. (Division of Materials Licensing (AEC), Washington, D. C.). [1970]. 5p. Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

A state of the art library of coupled neutron and gamma ray cross sections has been compiled for several elements commonly used for shielding calculations. A list of the nuclides in the library is given. (M.H.R.)

42368 (UCID-30023(Rev.1)) USER'S MANUAL FOR THE BUCKLE X-RAY DEPOSITION PROGRAM. Edwards, Arthur L. (California Univ., Livermore. Lawrence Livermore Lab.). 1 May 1972. Contract W-7405-eng-48. 37p. Dep. NTIS.

The BUCKL code has been adapted to run on the LLL CDC/6600 and CDC/7600 order systems. This version is called BUCKLE, and is available as BUCK66 for the CDC/6600 and BUCKLE for the CDC/7600. BUCKLE provides a means for fast calculation (several seconds per problem) of the deposition of x rays with energies in the 0.1 to 100,000 keV range in cool (nonionized) materials. The calculation includes the effects of photoelectric absorption, Compton absorption and scattering, pair production, fluorescence, scattering losses due to the finite diameter transverse to the incident beam, voids between materials, and losses at the front and back surfaces. Its agreement with more accurate codes that require much more computer time, is generally within 5 to 10%; and it is far more accurate than exponential codes, that only calculate absorption. A number of changes were made in the input and output data, in the method of calculating photoelectric cross sections, and in the methods of calculating currents and exit-spectrum intensities to simplify the use of the code, to make the calculations more accurate, and to provide all the necessary data for interpreting the results. Pair-production cross sections were added to extend the upper energy limit. A variable thickness option was added. The input and output data for users of the BUCKLE code are described. (auth)

42369 THRESHOLD ABSORPTION OF X RAYS IN METALS. Ginzburg, S. L. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 12, 3052-7(Jun 1972).

Translated from Fiz. Tverd. Tela; 13: No. 12, 3616-23(Dec 1971).

The absorption coefficient of x rays in metals is analyzed. It is shown that at low energies the absorption coefficient is proportional to $\omega^{-2\delta_0/\pi + \delta_0^2/\pi^2}$, where ω is the excess of x-ray quantum energy over the threshold, δ_0 is the phase of electron scattering by a heavy center of the Fermi surface. (auth)

42370 FORMATION OF THE ELECTRON ENERGY-LOSS SPECTRA IN IRON, COBALT, AND NICKEL. Bakulin, E. A.; Bredov, M. M.; Vasil'ev, V. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 12, 3114-15(Jun 1972).

Translated from Fiz. Tverd. Tela; 13: No. 12, 3689-91(Dec 1971).

In order to study the possible effect of an oxide film on the electron energy-loss spectra, energy-loss spectra of Fe_3O_4, CoO, and NiO were examined. Two energy-loss peaks appear in the spectrum of each oxide; they correspond to the losses ΔE_1 and ΔE_2 in the spectra of Co and Ni. A brief description of the band structure of the oxides is given. The ΔE_4 loss in the pure-metal spectra is a combination of the ΔE_3 and ΔE_1 losses in the oxide layer on the metal. (D.L.C.)

42371 RANGE MEASUREMENTS OF FISSION PRODUCTS. II. KINETIC ENERGY DEFICIT AND WIDTH OF THE ENERGY DISTRIBUTIONS. Pickering, Miles; Alexander, John M. (State Univ. of New York, Stony Brook, N. Y.). Phys. Rev., C; 6: No. 1, 343-52(Jul 1972).

Range measurements of fission products (^{97}Zr, ^{99}Mo, ^{105}Rh, ^{112}Pd, ^{115}In, ^{132}Te, ^{143}Ce) in gases have been compared with the range-energy tables of Northcliffe and Schilling. A reevaluation of the kinetic energy deficit for symmetric fission has been made, using a modification of these range-energy relationships. Experimental measurements of range distributions of fission fragments stopped in gases have been used to determine the width of the kinetic energy distributions as a function of product mass. The values obtained are compared with those from other workers. (auth)

42372 RANGE MEASUREMENTS OF FISSION PRODUCTS. I. COMPARISON WITH STOPPING THEORY. Pickering, Miles; Alexander, John M. (State Univ. of New York, Stony Brook). Phys. Rev., C; 6: No. 1, 332-43(Jul 1972).

Range distributions in H_2, He, Ne, and Ar are reported for seven fission products (^{97}Zr, ^{99}Mo, ^{105}Rh, ^{112}Pd, ^{115}In, ^{132}Te, ^{143}Ce). The method of electrostatic collection of these products has been explored, and high collection efficiencies are observed for most products. The width of the observed distributions is resolved into a contribution from the stopping effects and a contribution from the fission process. The average range values and the stopping straggling are compared with the theory of Lindhard, Scharff, and Schiøtt. The differences between theory and experiment are ≈ 5 to 50%. (auth)

42373 ULTRASOFT-X-RAY REFLECTION, REFRACTION, AND PRODUCTION OF PHOTOELECTRONS (100- TO 1000-eV REGION). Henke, Burton L. (Univ. of Hawaii, Honolulu). Phys. Rev., A; 6: No. 1, 94-104(Jul 1972).

The reflection, refraction, and associated production of photoelectrons by ultrasoft x rays (10 to 100 Å) can be important bases for the determination of material constants such as the linear x-ray absorption coefficients and the electron mean free paths. These may then be used to establish directly the photoionization cross sections and the electron-collision cross sections that account for the dominant energy-absorbing processes within solids for this energy region. Because the effective sample depths for these interactions are typically less than 100 Å, they constitute an important practical basis for surface characterization. By applying the exact theory for the reflection–refraction of a plane electromagnetic wave at an absorbing dielectric interface to the shorter-wavelength region (<10 Å), it can be shown that the conventional approximate theory of x-ray reflection is adequate. However, the more exact theory must be applied in the region of longer x-ray wavelengths (>50 Å). Although the derivations of the exact theory are tedious, the results can be expressed in relatively simple form as functions of two material constants α and γ, which are identifiable as the unit decrements to a complex dielectric constant, of the grazing-incidence angle, and of a parameter which is a function of this grazing angle and which becomes the angle of refraction for small angles of incidence. X-ray-absorption coefficients and electron mean-free-path values were determined from x-ray reflection and refraction and photoelectron excitation data. These values are shown to agree reasonably well with such material constants as determined by transmission measurements through thin samples. (auth)

42374 POLARIZATION OF BREMSSTRAHLUNG ALLOWING FOR MULTIPLE SCATTERING OF ELECTRONS. **Grushin, V. F. Kratk. Soobshch. Fiz.; No. 12, 24-8(Dec 1971). (In Russian).**

Without using any simplifying assumptions, an expression was obtained for the polarization arising from the use of a target of nonzero thickness. With the formulas developed, it was shown that accounting for multiple scattering of electrons, for example, in a Be target, lowered the values of polarization from 41% to 20%. (K.S.W.)

42375 MONTE CARLO ALBEDO MONOENERGETIC γ-RAYS NORMAL TO BARRIERS OF VARIOUS MEDIA. Pozdneev, D. B.; Krasnoshchekov, N. V.; Pichugin, A. V. This paper was summarized in At. Energ. (USSR); 30: No. 5, 449(May 1971) as paper No. 491/5952. (In Russian).

Full copy of this paper is held by TIC.

The Monte Carlo method is used for calculating, with a unidirectional source, the spectral-angular and integral characteristics of γ-quanta back-scattered from various media. The study investigates the case of the normal incidence of primary γ-quanta with an energy E_0 of 0.145, 0.279, 0.511, 0.662, 1.0, and 1.25 MeV on barriers made of Be, C, Al, Fe, and Sn, whose thickness in the normal direction measured 0.1, 0.2, 0.4, 0.6, 1.0, and 2.5 times the free-path length of the primary γ-quanta. By means of a scintillation γ-spectrometer an experiment was conducted to investigate the spectral-angular distribution of the reflected narrow-beam γ-radiation of ^{137}Cs from these media. (M.H.R.)

42376 X-RAY SPECTRAL DISTRIBUTIONS IN ROENTGENS. Storm, Ellery; Lier, Douglas W. (Los Alamos Scientific Lab., N. Mex.). Health Phys.; 23: No. 1, 73-84(Jul 1972).

Photon spectral distributions from four commercial x-ray units, containing tungsten targets and operating at tube potentials between 12 and 300 kV, were measured with germanium and silicon semiconductors, sodium iodide scintillators and a xenon proportional counter. After correction for detector distortions and the attenuation of the intervening material, the spectra were converted from photon flux to roentgens. Roentgen spectral distributions 50 cm from the target are given for all four units and are compared to rad spectral distributions for water, muscle and bone. A new method of characterizing spectral distributions in terms of an energy interval containing 80% of the exposure and in terms of the midpoint energy of this interval is described. L-line, K-line and continuum total exposures from each unit are given, together with line-to-total ratios. The total exposures measured by the spectrometer are compared to the exposures measured by a free-air ionization chamber. Total attenuation coefficients for air, energy absorption coefficients for air, water, muscle, and bone, and conversions from photon and energy flux to roentgens and rad, based on new theoretical calculations, are given. (auth)

42377 INCOHERENT SCATTERING CROSS SECTIONS AND ELECTRON BINDING. Gopal, S.; Sanjeevaiah, B. (Univ. of Mysore, India). pp 43-8 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

The incoherent scattering cross sections $(\sigma_b)_{expt}$ in carbon, aluminum and copper were determined at a photon energy of 280 keV and are compared with the cross sections (σ_f) calculated using Klein–Nishina formula. Values of $[\sigma_f - (\sigma_b)_{expt}]$ are found to increase with atomic number indicating the binding effects. The percentage deviations of the integrated incoherent bound electron scattering cross-sections $(\sigma_b)_{TF}$, $(\sigma_b)_H$ and $(\sigma_b)_{HF}$ computed on the basis of Thomas–Fermi (TF), Hartree (H) and Hartree–Fock (HF) models are calculated from the experimental values. These deviations are attributed to the limitations which are inherent in TF, H and HF models. (auth)

42378 MATHEMATICAL METHODS FOR ENERGY-DEPENDENT RADIATION TRANSPORT. Gopinath, D. V. (Bhabha Atomic Research Centre, Trombay, India). pp 49-68 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

A critical review of the methods available for energy-dependent radiation transport calculations is presented. The emphasis in the review is on the techniques for deep penetration studies with anisotropic scattering. The scope, principles and limitations of moments, P_N, double P_N, S_N, ANISN and ASFIT methods are discussed. (34 references) (auth)

42379 GAMMA DOSE RATE AT AN INTERNAL POINT ON X-Z PLANE OF SOLID RADIOACTIVE SPHEROID SOURCE. Gupta, P. C. (Inst. of Nuclear Medicine and Allied Sciences, Delhi). pp 135-41 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

An expression was derived for the gamma dose rate at a point situated on the X–Z plane inside a solid spheroidal source having uniform distribution of radioactivity. The general features of the pattern of dose distribution are discussed. The effect of change of shape keeping the volume the same (leading to a geometrical configuration factor) on the dose rate has been presented in detail. The results are compared with cylindrical and spherical sources of comparable geometry. (auth)

42380 CALCULATION OF GAMMA RADIATION DOSE FIELDS FROM A LINEAR SOURCE WITH COSINUSOIDAL AND UNIFORM DISTRIBUTION OF RADIOACTIVITY. **Bibergal, A. V.; Dunaev, L. M.; Drozdov, V. F.; Kaushanskii, D. A. Izotopy SSSR; No. 22, 24-9(1971). (In Russian).**

Formulas are given for the calculation of the γ radiation field from a source with cosinusoidal distribution of activity at an arbitrarily located point on the object being irradiated. The object is assumed to have the form of a circular cylinder or a rectangular parallelopiped. Testing of the formulas on the fuel elements of the VVR–TS reactor yielded satisfactory agreement between experimental and calculated data. (tr-auth)

42381 DISPLACEMENT CASCADES PRODUCED BY IRRADIATION. Corciovei, A. Rev. Roum. Phys.; 17: No. 3, 337-49(1972).

A charged particle moving through matter can lose its energy in two different ways — by elastic collisions with atomic nuclei and by inelastic collisions with atomic electrons. That region of velocities where the electronic stopping can be neglected is discussed (for protons, about 25 keV and lower). As the emphasis is on the nuclear part of the slowing-down process, concern is with the spatial distribution of the displaced atoms produced by an incident particle (primary atom) of a given energy. For a suitable scaling of the quantities involved, it is found that the nuclear slowing-down process is determined by a single universal function. The distribution function of the total path of the primary atoms and the vector radius of the end position of the primary atom are calculated. Extensive use of the hard-core approximation is made in the calculations. (R.W.R.)

42382 NOMOGRAMS FOR THE DETERMINATION OF THE ENERGY LOSS OF A CHARGED PARTICLE IN PASSING THROUGH A LAYER OF MATTER. **Potetyunko, G. N. At. Energ. (USSR); 32: No. 5, 430-3(May 1972). (In Russian).**

Nomograms were constructed from two equations for the rapid estimation of the loss of energy by charged particles during their passage through matter. The essential variables are the energies before and after encountering the absorber, the absorber thickness, and the energy per nucleon. (4 figures, 1 table) (K.S.W.)

42383 TWO-GROUP PROBLEMS IN RADIATIVE TRANSFER AND NEUTRON-TRANSPORT THEORY. **Reith, Raymond John Jr. Raleigh, N. C.; North Carolina State Univ. (1971). 146p. University Microfilms Order No. 72-15,903.**

Thesis.

The singular-eigenfunction-expansion technique is employed to study the two-group, time-independent transport equation. The normal modes for the two-group equation with linearly anisotropic scattering are developed and the necessary full-range completeness and orthogonality theorems are established. Half-space problems are investigated within the restriction of isotropic scattering, and accurate numerical solutions are reported for the Milne problem. Two-group transport theory in two adjacent half-spaces is studied within the assumption that the determinant of the transfer matrix vanishes, and useful "two-media" orthogonality relations are derived for a special case. A problem in nongrey radiative heat transfer in a finite plane-parallel medium with reflecting and emitting boundaries is solved using the two-group formalism. The solution is represented by a sum of the normal modes, and appropriate orthogonality relations are invoked to obtain a set of regular integral equations for the required expansion coefficients. These integral equations are solved numerically, and results for the heat-flux and temperature-profile functions are given for a representative class of cases. (Diss. Abstr. Int., B)

Radiation Protection Standards

42384 ABSOLUTE CALIBRATION OF THE BARC THERMAL NEUTRON FLUX STANDARD USING MANGANESE–NICKEL ALLOY. Sharma, D.; Shahani, M. G. (Bhabha Atomic Research Centre, Trombay, India). pp 217-27 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

The thermal neutron flux density standard maintained at Trombay was absolutely measured in terms of the thermal neutron absorption cross-section of ^{55}Mn by using manganese-nickel alloy foils. A beta-gamma coincidence technique is used for determining ^{56}Mn activity. The value of the flux density obtained is in good agreement with the previous value which was obtained by using thin gold foils. The relevant correction factors and relative accuracies of the manganese and gold measurements are also discussed. (auth)

Radiation Source Calibration and Standardization

Refer also to abstracts 40691, 40692, 40894, and 42385.

42385 NATIONAL BUREAU OF METROLOGY. Grinberg, B. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 163, 7-10(Oct 1971). (In French).

The aims of the National Bureau of Metrology and its preliminary objectives are presented. Information is given on the system of primary and secondary standards used. (France)

42386 PRIMARY STANDARDS LABORATORY FOR THE METROLOGY OF IONIZING RADIATIONS. Le Gallic, Y. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 163, 11-18(Oct 1971). (In French).

The objectives of the primary standards laboratory are to manufacture and store primary standards, to produce secondary standards, to improve measurement methods, and to determine fundamental constants (decay schemes, half-lives, etc.). Consideration is given to all these aspects, the problem of coordination on the national scale being given particular attention. (France)

42387 ^{252}Cf DOSIMETRY FOR RADIOLOGICAL APPLICATIONS. Krishnaswamy, Vasudevasastri. Philadelphia; Univ. of Pennsylvania (1971). 162p. University Microfilms Order No. 72-6189.

Thesis.

Medical interstitial and intracavitary radiotherapy use radium and other gamma ray sources in the form of needles. Recently, californium-252, a spontaneous fission neutron source has become available for such applications. This source emits both neutrons and gamma rays. A possible advantage of this source is the release of high linear energy transfer particles having enhanced relative biological effectiveness by neutrons interacting with tissue. Proper use of such a source requires precise knowledge of the energy deposited to tissue by neutron and gamma rays in the neighborhood of the needle source. A Monte Carlo technique is applied to evaluate the neutron dose along with its constituent components from a point californium-252 source, in a tissue sphere. The dose due to gamma rays emitted by the source is determined from the known specific absorbed fraction and energy absorption build-up factors for the energy spectrum of the gamma rays emitted by the source. The effect of the absorber size on the neutron source is investigated. The neutron linear energy transfer distributions about a point californium-252 source for various distances from the source are calculated. The point source dose distribution is utilized to determine the dose distribution about linear sources. The total gamma dose is the sum of the dose due to primary gamma rays from californium-252 and the gamma dose due to thermal neutron capture in hydrogen. Primary gamma dose calculation is carried out taking into account the effect of self-absorption in the platinum screen and the wire on which the source is electrodeposited. The measurement of neutron and gamma depth dose about an applicator californium-252 tube is carried out using Rossi's thin, flat, tissue-equivalent and aluminum gas-multiplying ionization chambers. These measurements are also compared with the measurement using thermoluminescent lithium fluoride extruded rods for the gamma dose and spherical tissue-equivalent ionization chamber for the neutron dose. Results obtained from the calculation and measurement are compared separately for the neutron and gamma component for the dose. Excellent agreement between the calculated and the measured values was obtained for the neutron dose. The measured dose with the thin, flat, aluminum chamber was about 8% less than the calculated gamma dose. The data obtained with thermoluminescent dosimeters were unable to resolve this difference because their precision proved to be very poor in the mixed neutron gamma field. (Diss. Abstr. Int., B)

42388 PHANTOM DEPTH DOSE DISTRIBUTIONS FROM PANOREX DENTAL X-RAYS. Nelson, Robert C.; Rupp, Ted D. (Air Force School of Aerospace Medicine, Brooks AFB, Texas). Oral. Surg., Oral Med., Oral Pathol.; 32: No. 6, 982-9(Dec 1971).

Complete head depth dose distributions were obtained from several Panorex dental x-ray units operating at identical KVP and Ma. settings. Depth dose distributions were also obtained on the same unit with varying KVP and Ma. settings. An average-man Rando phantom into which were placed TLD-100 capsule dosimeters was utilized for the study. The resulting depth dose distributions allow the determination of absorbed doses in areas of interest and the recognition of variations between individual Panorex units. (auth)

42389 DOSIMETRIC AND FLOW ANALYSES OF A 100-CURIE ^{90}Sr BLOOD IRRADIATOR. Hertz, Marvin Ben. Nashville; Vanderbilt Univ. (1971). 147p. University Microfilms Order No. 72-3216.

Thesis.

A 100-Curie strontium-90 extracorporeal blood irradiator was obtained by Vanderbilt University Hospital for potential clinical application in the treatment of leukemia and in organ transplantation. To assure effective and safe treatment of patients, dosimetric and flow analyses of the irradiator were performed. The absorbed radiation dose to Fricke dosimeter solution, which has absorption properties similar to blood was measured at a series of flow rates for different tubings. The absorbed dose varied linearly with mean residence time of the solution in the irradiator. The absorbed dose rate decreased with increased thickness of tubing. An aluminum shielding experiment showed that bremsstrahlung emission was negligible. The axial and radial radiation distributions across the irradiation channel for $^1/_4$-in. OD–$^3/_{16}$-in. ID tygon tubing was determined using lithium fluoride thermoluminescent dosimeters. The radiation exposure was constant along the axis of the irradiation section and fell rapidly at the ends of the irradiation section. The radiation dose rate decreased considerably from the tubing wall to the tubing axis. The dose rate as a function of radial position is given by $DR = 1000\ r^{3.73} + 15{,}600$. An average dose rate of 72,200 rads per minute was predicted from the radial radiation distribution assuming laminar flow through the irradiation section. An average dose rate of 71,500 rads per minute was measured with the Fricke dosimeter solution. Blood behaves as a Newtonian fluid for flow rates through the irradiator exceeding approximately 25 ml per minute. The channel curvature in the irradiator does not distort the laminar velocity profile as the blood passes through the irradiation section. Black dye was injected into a 45 wt. % glycerolwater solution flowing through a prototype of the irradiation channel and the developing velocity profile photographed. A 45 wt. % glycerol–water solution has a viscosity and density similar to blood. Flow rates of 200 ml per minute and 500 ml per minute were observed. The developing velocity profiles and the streamlines of dye obtained by a continuous injection of dye showed negligible distortion across the channel. The concentration of leukocytes and erythrocytes was found to be constant across the diameter. Differential leukocyte counts at various radial positions across the diameter showed negligible variation in the leukocyte population. (Diss. Abstr. Int., B)

Shielding Calculations and Theory

Refer also to abstracts 41504, 42588, and 42640.

42390 OPTIMIZATION OF THE SHAPE OF A SHADOW SHIELD AGAINST NEUTRONS FROM A SURFACE SOURCE BY THE MONTE CARLO METHOD. Generozov, V. L.; Sakovich, V. A. This paper was summarized in At. Energ. (USSR); 30: No. 6, 536-7(Jun 1971) as paper No. 501/5921. (In Russian).

Full copy of this paper is held by TIC.

The results are presented of optimizing the shape of a shadow shield against monoenergetic neutrons from a surface source by using the Monte Carlo method to compute the dose and its first derivatives with respect to the varied shield parameters. The optimization was performed for cylindrical and disk surface sources of 8-MeV neutrons with cosine angular distributions. The generator of the axially symmetric shadow field was approximated by a stepped line with the height of each step subjected to variation. The original shield was a slab of polyethylene 30-cm thick. The minimum neutron dose averaged over a circular shielded region coaxial with the source and 13 m from it was sought. The weight of the shield was kept constant. (M.H.R.)

42391 VALIDITY OF THE EMPIRICAL FORMULAE FOR BUILDUP FACTORS IN MULTIREGION SYSTEMS. Gopinath, D. V.; Santhanan, K. (Bhabha Atomic Research Centre, Trombay, India). pp 111-18 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

Buildup factor defined as the ratio of the total detector response to the virgin radiation response is a convenient concept in radiation attenuation calculations. While simple buildup factors are possible and a large amount of data exists in the case of homogeneous systems, data on buildup factors in multiregion systems are scanty and they are not amenable to any simple systematics. There have been several attempts to provide empirical formulae, all necessarily approximate, for the buildup factors in multiregion systems. The results obtained from these formulae are compared with exact calculations made with the ASFIT code. In the light of deviations between the two results, the limitations of the empirical formulas are discussed. An improvement based on the physics of scattered radiation is suggested. (auth)

PHYSICS (SOLID-STATE)

42392 AMORPHOUS MATERIALS. Papers Presented to the Third International Conference on the Physics of Non-Crystalline Solids, Sheffield, England, September 1970. Douglas, R. W.; Ellis, Bryan (eds.). London; John Wiley and Sons Ltd (1972). 550p. £9. (CONF-700981).

Of the 52 papers presented in sections covering relaxation processes, the transformation range, viscosity and diffusion processes, structure, nuclear magnetic resonance and electron spin resonance studies, vibrational properties, and fracture, one was in scope and a separate abstract was prepared. (UK)

For an abstract of an individual paper see: 42408.

Radiation Effects

Refer also to abstracts 41683, 41689, and 42466.

42393 (BNL-16398) QUANTITATIVE STUDIES ON RADIATION INDUCED DISLOCATIONS AND THE DECOMPOSITION KINETICS OF AMMONIUM PERCHLORATE. Herley, P. J.; Levy, P. W. (Brookhaven National Lab., Upton, N. Y.). 1972. 9p. (CONF-720703-1). Dep. NTIS.

From seventh international symposium on the reactivity of solids; Bristol, England (17 Jul 1972).

Ammonium perchlorate crystals exposed to gamma or x irradiation exhibit etch-pit movement and greatly increased etch-pit concentrations. Few dislocations are induced below 10^5 rad, between 10^5 and 10^6 rad the concentration increases linearly, and above 10^6 rad the concentration is too large to determine accurately. These results suggest an explanation for the increased thermal decomposition rate and shortened induction period exhibited by crystals exposed to radiation prior to decomposition. Namely, since dislocations become decomposition nuclei, the accelerated decomposition rates result from the additional dislocations, i.e., nuclei, introduced during irradiation. Apparently trapped gaseous decomposition products, e.g., in voids, exert sufficient stress to generate dislocations by well-known mechanisms. (auth)

42394 (GIPR-25) NOBLE GAS ION COLLECTION IN COPPER SINGLE CRYSTALS. Kugler, E. (Chalmers Tekniska Hogskola, Goteborg (Sweden). Institutionen for Fysik). Feb 1970. 13p. Dep. NTIS (U. S. Sales Only).

Using a radioactive tracer method, saturation values and collection efficiencies for trapping of 40-keV Kr ions in Cu (100) and (111) single crystals as well as in polycrystalline copper are measured. The saturation quantities show a marked dependence on the angle of incidence which is compared with the critical angle of channeling. Values of the projected ion range are estimated, applying a simple theory of ion trapping and a comparison is made of the values thus determined with other range measurements. (auth) (Sweden)

42395 (JPRS-56287) EFFECT OF THE RADIATION STABILITY OF SEMICONDUCTORS WITH STOICHIOMETRIC VACANCIES. Koshkin, V. M.; Gal'chinetskii, L. P.; (and others). Translated from Fiz. Tverd. Tela; 14: No. 2, 646-8(1972). 5p. NTIS.

The response of single-crystal and polycrystalline In_2Te_3, Ga_2Te_3, CdTe, and ZnTe irradiation with γ quanta, fast electrons, fast neutrons in a pulse reactor, and mixed reactor radiation under steady-state conditions was studied. (auth)

42396 (SC-DC-722290) RADIATION DAMAGE EFFECTS IN MICROWAVE DIELECTRIC SUBSTRATE MATERIALS. Wilson, W. E.; Chaffin, R. J. (Sandia Labs., Albuquerque, N. Mex.). [1970]. 4p. (CONF-720707-1). Dep. NTIS.

From Annual conference on nuclear and space radiation effects; Seattle, WA. (24 Jul 1972).

Studies were made on the effects of γ and neutron radiation on the microwave electrical properties of commonly used substrate materials, specifically aluminum oxide (as typically used in microstrip circuits) and Teflon-glass (as typically used in stripline circuits). The results showed that the aluminum oxide circuits changed colors at low γ levels (10^5 rads), but their microwave properties appeared unchanged to 10^8 rads γ and 2×10^{15} nvt. When exposed to γ irradiation, Teflon-glass circuits showed a gradual increase in both dielectric constant and loss tangent. No degradation could be attributed to neutron displacement damage for the Teflon-glass circuits to 2×10^{15} nvt ($E > 10$ keV). The maximum fluence at which Teflon-glass microwave circuits can be used will depend on specific system requirements for the allowed Q change and frequency shift. (P.C.H.)

42397 POLYMORPHIC TRANSFORMATIONS OF CdS AND α-Al_2O_3 UNDER ELECTRON IRRADIATION AND THERMO-DIFFERENTIAL ANALYSES. Teodorescu, G. (Bucharest Polytechnic Inst.); Jitianu, G.; Ciomirtan, D. (Rev. Roum. Phys.; 17: No. 1, 71-80(1972).

A study was made of thin layers of cadmium sulfide and aluminum oxide (obtained by precipitation from emulsions on collodion films) under the action of electrons accelerated at 60 kV or more. Before irradiation, these substances were analyzed by means of x rays. At the beginning of irradiation, the thin layers presented single crystal phases: cubic for CdS and trigonal for Al_2O_3-α. After the irradiation, both substances changed into amorphous phase. If the irradiation continued at higher accelerating voltages, polymorphic changes appeared both in CdS and Al_2O_3-α, namely from amorphous phase into crystalline phase. Results are correlated by using electronograms and thermodifferential analyses. The thermograms for CdS and Al_2O_3-α are presented. (auth)

42398 RADIATION-INDUCED COLOURING AND HARDENING BEHAVIOUR OF KCl:U CRYSTALS. Cabrera, J. M. (Junta de Energia Nuclear, Madrid); Agullo-Lopez, F. Cryst. Lattice Defects; 3: No. 1, 41-5(Feb 1972).

The effect of prior U-center doping on the γ-irradiation-induced coloring and hardening of KCl single crystals was investigated. In doped crystals, the F-coloring curve consists of a fast initial growth due to U → F conversion, followed by an essentially flat stage whose length increases with U-center concentration. At higher dose, a new rise in the F-center production rate is observed and leads to the so-called late stage. At the same time, the uv spectrum in the V_2 band region experiences a marked enhancement. On the other hand, the hardening curves of the doped crystals show an initial hardening-free region whose length also increases with U-center concentration. This region can be correlated with the flat stage of the coloring curve and for both cases its length depends on the square of the initial U-center concentration. The increase in yield stress can be unequivocally correlated with the absorption coefficient at 250 mμ regardless of the amount of U doping. In the range of dose investigated (up to $\sim 5 \times 10^7$ R), the dependence follows a square root law as predicted by rapid hardening. The coloring and hardening behavior can be interpreted in terms of secondary interstitial processes. (auth)

42399 MATRIX ENDOR LINEWIDTHS OF TRAPPED ELECTRONS IN GLASSY MATRICES AT 77°K. Helbert, John (Wayne State Univ., Detroit); Kevan, Larry; Bales, Barney L. J. Chem. Phys.; 57: No. 2, 723-7(15 Jul 1972).

Matrix ENDOR lines of protons associated with trapped electrons in γ-irradiated glassy matrices of 10M NaOH, methanol, and 2-methyltetrahydrofuran at 77°K were observed. By analysis of the matrix ENDOR line shapes under comparable experimental conditions, the linewidth was related to the spatial extent of the ground state wavefunction of the trapped electron. These experimental results are compared with predictions of the semicontinuum model for trapped electrons and found to be in good agreement. (auth)

42400 LOW-TEMPERATURE OPTICAL DESTRUCTION OF F CENTERS IN KCl-KOH AND KBr-KOH. Kats, M. L.; Golubentseva, L. I.; Gyunsburg, K. E. (Saratov State Univ., USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 12, 3151-2(Jun 1972).

Translated from Fiz. Tverd. Tela; 13: No. 12, 3723-4(Dec 1971).

An experimental study was made of the optical destruction of F centers in KCl-1 mole% KOH and KBr-1 mole% KOH crystals subjected to x rays at 20 and -140°C. The results show that F-light destruction of F centers is more efficient in the doped crystals than in the pure crystals, and that this effect is very pronounced at -140°C. The low stability of the F centers may be due to singly charged O_2^- ions. If x-irradiated KBr-KOH is kept in darkness at -140°C, no F centers are destroyed. (D.L.C.)

42401 TRANSIENT FORMATIONS OF COLOR CENTERS IN KBr CRYSTALS UNDER THE PULSED ELECTRON BEAM. Kondo, Yasuhiro; Hirai, Masamitsu; Ueta, Masayasu (Tohoku Univ., Sendai). J. Phys. Soc. Jap.; 33: No. 1, 151-7(Jul 1972).

Transient formation of F, H, and α centers and self trapped excitons was investigated in KBr crystals by the irradiation of the pulsed electron beam from a Linac (30 MeV, 0.8 A, 20 ns) and a Febetron 706 (0.6 MeV, 7000 A, 3 ns). The α center concentration is at most 1/25 of that of the F center. The F and H center pair is concluded to be the primary product. The fast growth times of F and H centers, which are shorter than 3 ns, suggest that the lowest triplet and singlet states of the trapped exciton do not have any direct participation in the F center formation. (auth)

42402 REDUCTION OF THE COHERENCE AREA OF HIGH-ENERGY ELECTRONS IN THE PASSAGE THROUGH A CRYSTAL. Ferretti, B. (Univ., Bologna. CERN, Geneva). Nuovo Cim.; 9B: No. 2, 399-413(11 Jun 1972).

This problem was suggested by an investigation of photo-Coulomb interference arising from coherent bremsstrahlung. The answer is that the coherence area is reduced to atomic dimensions after a path of a few microns only. (auth)

42403 NUMERICAL INTEGRATION OF THE GAMMA TRANSPORT EQUATION WITH AN AZIMUTH-DEPENDENT SOURCE. Penkuhn, H. (EURATOM-CCR, Ispra, Italy). pp 219-22 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The Compton scattering integral with an azimuth-dependent source is integrated numerically for iron, water, and lead. The results are compared with Monte Carlo calculations. The average deviations amount to 2% for iron, 3% for water, and 9% for lead. (auth)

42404 CONVERGENCE OF DIFFERENCE METHODS IN ONE-DIMENSIONAL AND TWO-DIMENSIONAL TRANSPORT CODES. Hehn, G.; Havranek, M. (Univ., Stuttgart). pp 223-6 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Comparative studies were performed with existing P_L and S_N computer codes, such as PLK, ANISN and DOT. The lattice of the base points and the angular treatment were refined systematically so that the different convergence of the computer codes could be studied with a view to shielding problems. (auth)

42405 DETERMINATION OF THE DIFFERENTIAL ALBEDO FOR GAMMA RAYS WITH A BETATRON AS RADIATION SOURCE. Vogt, H. G. (Technische Univ., Hanover). pp 231-4 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A method is described by means of which the energy- and angle-dependent albedo of photons (betatron bremsstrahlung) can be measured within a larger continuously related energy range. The method was tested using Al as the scatterer in the energy range from 2 to 17 MeV. A program system for the CDC-1604A was developed for the fully automatic spectrum evaluation in terms of albedo values. (auth)

42406 BORON ATOM DISTRIBUTIONS IN ION-IMPLANTED SILICON BY THE (n,^{4}He) NUCLEAR REACTION. Ziegler, J. F. (IBM Watson Research Center, Yorktown Heights, N. Y.); Crowder, B. L.; Cole, G. W.; Baglin, J. E. E.; Masters, B. J. Appl. Phys. Lett.; 21: No. 1, 16-17(1 Jul 1972).

The concentration distribution of ^{10}B atoms ion-implanted into silicon was determined with a new nuclear reaction technique. The concentration profiles for implantations in the energy range 40 to 500 keV were determined before and after annealing at 900°C for 30 min; they show that enhanced diffusion, because of radiation damage, is of minor importance. The profile ranges and widths were compared to Lindhard–Scharff–Schiott theory and to other experiments. (auth)

42407 PHOTOCONDUCTIVITY OF CdS CRYSTALS IRRADIATED WITH FAST ELECTRONS. Yoshida, Toshio; Oka, Takashi; Kitagawa, Michiharu (Radiation Center of Osaka Prefecture). Appl. Phys. Lett.; 21: No. 1, 1-2(1 Jul 1972).

The effects of 10-MeV electron irradiation on the photoconductivity of CdS single crystals were studied. Irradiation causes the appearance or increase of photoconductivity in the wavelength ranges from 0.8 to 3 μ (the 1-μ band), from 0.55 to 0.8 μ, and from 0.46 to 0.5 μ (the exciton band). The 1-μ band is attributed to radiation-produced defects located at levels from 0.4 to 1.6 eV below the bottom of the conduction band. The excitonic band results from dissociation of excitons at some kinds of radiation-produced defects. (auth)

42408 ESR AND OPTICAL ABSORPTION SPECTRA OF IRRADIATED LEAD BORATE GLASSES. Arafa, S.; Bishay, A. (American Univ., Cairo). pp 409-19 of Amorphous Materials. /Douglas, R. W. (ed.). London; John Wiley and Sons Ltd. (1972).

From third international conference on the physics of non-crystalline solids; Sheffield, England (Sep 1970). See CONF-700981.

The ESR of some γ-irradiated borate glasses containing lead oxide is discussed in relation to the induced optical absorption, and a comparison is made between the spectra induced in some of these glasses and in alkali borate glasses. The results indicate clearly that the optical band at about 1.6 eV and the ESR line at $g \simeq 1.996$ induced in irradiated lead borate glasses are due to the same centre. This centre is an electron-trap centre in the vicinity of lead ions, and the associated band and ESR line reach their maximum intensity in glasses containing about 25 mole % PbO. In the case of irradiated alkali borate glasses, a change in the role of PbO in the glass structure is indicated as the PbO content exceeds 25 mole %. It is postulated that lead has a much higher ionic character in glasses containing less than 25 mole % PbO as compared with those containing higher concentrations of PbO. (UK)

42409 LOCATION OF INTERSTITIAL DEUTERIUM SITES IN NIOBIUM BY CHANNELING. Carstanjen, H. D.; Sizmann, R. (New York Univ., N. Y. Univ., Munich). Phys. Lett.; 40A: No. 2, 93-4(3 Jul 1972).

Channeling of 300-keV deuterons combined with the D(d,p)T reaction was used to determine the positions of deuterium dissolved in niobium. Comparison of experimental data with theoretical reaction yield calculations indicates that deuterium in niobium is located on tetrahedral lattice sites. (auth)

42410 ANALYSIS OF THE R_2 ABSORPTION STRUCTURES IN LiF, KCl, AND KBr. Giesecke, P. (Technische Hochschule, Darmstadt, Ger.); von der Osten, W.; Roeder, U. Phys. Status Solidi (b); 51: No. 2, 723-34(1 Jun 1972).

Starting from the linear and quadratic electron–phonon coupling for defects in crystals, a method is described to obtain the one- and multiphonon contributions to the optical absorption structure for the case of intermediate coupling strength. It is based on the explicit knowledge of the absorption shapes of the zero-phonon line and the vibrational sideband, which have to be measured with high spectral resolution as a function of temperature. The analysis is performed for the R_2 transition of the R center in LiF, KCl, and KBr. The peaks of the spectral density of coupled modes resulting from the analysis are compared with characteristic phonon energies at the Brillouin zone boundary and to results of circular dichroism measurements of the R_2 band. The linear coupling coefficient S is obtained (a) from the Fourier transform of the one-phonon absorption spectrum, (b) from the ratio of the integrated absorption of the zero-phonon line and the total band, and (c) from a calculation using the density of states obtained by the sideband analysis. Taking into account the quadratic coupling, from the spectral density of coupled modes both thermal shift and broadening of the R_2 zero-phonon line are predicted and prove to be in good agreement with the experimental data. A static contribution to the line shift as well as a residual line width at low temperature thereby have been taken into account. (auth)

42411 EPR STUDIES OF IMPURITIES IN ELECTRON-IRRADIATED CaO. Henderson, B. (Oak Ridge National Lab., Tenn. Keele Univ., Staffordshire, Eng.); Tohver, H. T. Phys. Status Solidi (b); 51: No. 2, 761-8(1 Jun 1972).

The EPR spectrum of Mn^{4+} ions in CaO was observed in single crystals containing Li^+ or Na^+ ions. Electron irradiation of such crystals results in Mn^{4+} being converted to Mn^{2+}, a concomitant reaction being the formation of $[\mathrm{Li}]^0$ and $[\mathrm{Na}]^0$ trapped-hole centers. Several other paramagnetic species are produced by the irradiation including atomic hydrogen, $[\mathrm{Li}_2^+]^-$ and $[\mathrm{Li}^+\mathrm{H}]^+$ centers. The spin Hamiltonian parameters that describe the EPR spectra of these impurity centers are reported and discussed. Optical or thermal bleaching of the $[\mathrm{Li}]^0$ or $[\mathrm{Na}]^0$ centers above 77°K results in the annihilation of Mn^{2+} and $[\mathrm{Li}^+\mathrm{H}]^+$ centers: atomic hydrogen and the $[\mathrm{Li}_2^+]_R^-$ centers are less readily bleached by these treatments. (auth)

42412 ENDOR MEASUREMENTS OF THE V_1 CENTER IN IRRADIATED BeO. Maffeo, B.; Herve, A.; Rius, G.; Santier, C.; Picard, R. (CEN, Grenoble, France). Solid State Commun.; 10: No. 12, 1205-8(15 Jun 1972).

The parameters of the nuclear magnetic and quadrupolar interactions with the beryllium nuclei nearest neighbours to the "axial" V_1 center were measured by ENDOR. The results are in agreement with the model of a hole trapped by an isolated cation vacancy. (auth)

42413 ION IMPLANTATION IN SEMICONDUCTOR DEVICE TECHNOLOGY. Stephen, J. (Atomic Energy Research Establishment, Harwell, Eng.). Radio Electron. Eng.; 42: No. 6, 265-84(Jun 1972).

The role of ion implantation in the fabrication of semiconductor devices is reviewed with special reference to silicon planar technology. The applications of ion implantation to various devices is discussed in detail. A summary is given of the present state of the art in the compound semiconductor field. (auth)

42414 RADIATION DAMAGE INDUCED BY CHANNELING OF HIGH ENERGY ELECTRONS. Fujimoto, F. (Tokyo Univ.); Fujita, H. Phys. Status Solidi (a); 11: No. 2, K103-4(16 Jun 1972).

The electron micrograph of a stainless steel after irradiation by 2-MeV electrons shows a very high density of dislocation loops where the beam is parallel to the $\langle 100 \rangle$ axis. The axial channeling parameter α_a is calculated to be 7.0, indicating that the particle model of channeling is suitable. Planar channeling was studied for an Al specimen irradiated by 2-MeV electrons; bend contours of (111) and $(\bar{1}\bar{1}\bar{1})$ reflections and dislocation loops were observed. The parameter α_p is 2.3, confirming the classical model. (D.L.C.)

42415 PROPERTIES OF 1 MeV ELECTRON-IRRADIATED DEFECT CENTERS IN p-TYPE SILICON. Walker, J. W.; Sah, C. T. (Univ. of Illinois, Urbana). Phys. Status Solidi (a); 11: No. 2, 513-22(16 Jun 1972).

Thermal emission rates of holes, activation energies, and annealing behavior of defects introduced in p-type silicon by 1.0-MeV electron irradiation were determined from dark-junction capacitance and current transient measurements. Three donor levels are introduced at room temperature at 386, 317, and 207 MeV above the valence band. Donor levels at 328 and 260 MeV are generated by heating at 170 and 225°C, respectively. Only the 386 MeV levels survived 400°C heat treatment. These levels are independent of boron concentration and are from different defect centers. (auth)

42416 STAGE I RECOVERY OF MOLYBDENUM IRRADIATED AT 4.2°K WITH ELECTRONS OF DIFFERENT ENERGIES. Afman, H. B. (Univ., Amsterdam). Phys. Status Solidi (a); 11: No. 2, 705-12(16 Jun 1972).

Results are given, and together with previously obtained data, are compared with the existing theory of the analogous recovery of fcc metals. It is concluded that a new defect type is needed in order to explain the main recovery step at 40°K. Requirements that the defect has to meet are listed and a tentative proposal of such a new defect is made. (auth)

42417 GAMMA RADIATION EFFECTS IN LITHIUM NIOBATE. Smith, Richard W. (WADCO Corp., Richland, Wash.). Proc. IEEE (Inst. Elec. Electron. Eng.); 59: No. 4, 712-13(Apr 1971).

Lithium niobate transducer plates were irradiated from a ^{60}Co source. The piezoelectric coupling factor, the dielectric constant, and the frequency constant were measured at progressively higher radiation levels. No change was observed for radiation levels up to 10^{10} R total dose. (auth)

42418 OPTICAL ABSORPTION OF THE V_{OH} CENTER IN MgO. Kappers, Lawrence A.; Dravnieks, Fricis; Wertz, John E. (Univ. of Minnesota, Minneapolis). Solid State Commun.; 10: No. 12, 1265-9(15 Jun 1972).

An optical absorption band which peaks at 2.21 eV at room temperature is assigned to the V_{OH} center in MgO, a linear defect consisting of the array O^{+} [=] HO^{+}, where only deviations from the normal site charge are shown. This band is very similar to that of the V^{-} center. The relative oscillator strengths of the transitions are estimated to be $f(V_{OH})/f(V^{-}) = 0.70 \pm 0.1$. (auth)

Physical Properties

Refer also to abstracts 40866, 41429, 42059, and 42102.

42419 (AD-735120) PREPARATION AND PROPERTIES OF RARE-EARTH COMPOUNDS. Semiannual Technical Report, June 4, 1971–January 3, 1972. Wood, Van E.; Brog, Kenneth C.; Austin, Alfred E.; Miller, James F.; Jones, William H. Jr. (Battelle Columbus Labs., Ohio). 4 Jan 1972. Contract DAAH01-70-C-1076. 46p. NTIS.

Preparation, characterization, and physical properties of rare-earth compounds of technological potential are described. Work was in the areas of magnetoferroelectric materials and of narrow-band narrow-gap semiconductors. In the former area, the primary objective was to develop a simultaneously ferroelectric and ferromagnetic device element operating in a useful temperature range. Solid solutions of rare-earth manganites, chromites, and ferrites were the main object of investigation. Narrow-band narrow-gap semiconductors undergoing purely electronic semiconductor-to-metal transitions are of considerable practical and fundamental interest. The transitions investigated were the pressure-induced ones in the Sm chalcogenides. Work is continuing on solid solutions of similar composition. Some of these materials display strong white cathodoluminescence. (auth) (NTIS)

42420 (BMBW-FBK-72-2) STRUCTURE ANALYSIS BY THERMAL NEUTRON DIFFRACTION. II. THE MAGNETIC STRUCTURE OF $DyPO_4$, α-$ErAl_3$, AND $Mn_{0.5}V_{0.5}Te$, CRYSTAL STRUCTURE INVESTIGATION OF $Hg_3S_2F_2$. Will, G.; Scharenberg, W.; Schaefer, W.; Bargouth, M. O. (Bonn Univ. (West Germany). Mineralogisches Institut). Mar 1972. 37p. (In German). Dep. NTIS (U.S. Sales Only).

The beam intensity was increased by the use of graphite monochromators. A powder Laue technique was developed with a graphite crystal as the energy analyzer. The following studies were reported: (1) the magnetic structure of $DyPO_4$, which crystallizes with the zircon type structure; antiferromagnetic ordering is observed below 3.4°K; (2) the magnetic structure of $Mn_{0.5}V_{0.5}Te$, which crystallizes with the NiAs structure and undergoes an antiferromagnetic transition at 220°K; (3) the magnetic structure of hexagonal α-$ErAl_3$, which orders antiferromagnetically below 5°K; and (4) crystal-structure investigation of $Hg_3S_2F_2$, performed in connection with an x-ray-diffraction study. (auth)

42421 (COO-3164-1) ORDERING OF HYDROGEN IN β-VANADIUM HYDRIDE. Report No. 1642. Wanagel, J.; Sass, S. L.; Batterman, B. W. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). Jul 1971. Contract AT(11-1)-3164. 24p. Dep. NTIS.

Electron-microscope specimens of vanadium, thinned by a technique known to add hydrogen, showed evidence for ordering in β-vanadium hydride. Extra half-order reflections were observed and concluded to be due to scattering from hydrogen. The transformation between the ordered and disordered phases occurs reversibly at a specific temperature in the range 160 to 190°C, depending on the specimen. The reciprocal lattice as determined by electron diffraction was shown to be in the monoclinic Laue group. Indirect evidence places the composition of the ordered phase in the vicinity of V_2H. The possible monoclinic structures consistent with observations place the hydrogens in tetrahedral sites on alternate $(101)_{bct}$ planes. (auth)

42422 (IS-T-505) RESISTIVITY AND MAGNETORESISTANCE OF DILUTE SOLUTIONS OF Cr IN Cu-Ni ALLOYS. Eagen, Charles Frederick (Ames Lab., Iowa). May 1972. Contract W-7405-eng-82. 70p. Dep. NTIS.

Thesis.

The electrical resistivity from 1.3 to 100°K and the longitudinal magnetoresistance from 0 to 85 kOe at 4.2°K were measured on Cu−Ni (Cr) alloys with Ni concentrations of 0, 6, 13, and 23 at. % and Cr concentrations of 0, 125, 300, 600, and 1200 at. ppm. All Cr-bearing samples were observed to exhibit resistivity minima. The difference in resistivity between each Cu−Ni (Cr) alloys and its Cr-free equivalent did not depend linearly on log(T); the difference in magnetoresistance between these two alloys was found to be negative. The Cr-impurity contribution to the resistivity and magnetoresistance showed a marked dependence on the Ni concentration and was proportional to the Cr concentration only in the alloys containing 23 at. % Ni. These results are discussed in terms of spin-flip scattering processes, characteristic of the Kondo effect, subject to Cr−Cr interactions and the local Ni environment around a Cr cell. (auth)

42423 (IS-T-511) ELECTRONIC STRUCTURE AND FERMI SURFACE OF RHENIUM TRIOXIDE. Myron, Harold William (Ames Lab., Iowa). May 1972. Contract W-7405-eng-82. 64p. Dep. NTIS.

Thesis.

Energy bands were calculated for the simple cubic metallic rhenium trioxide using the Korringa−Kohn−Rostoker (KKR) method. Calculations were performed both for an equilibrium lattice constant and a compressed lattice constant, and the Fermi surface was investigated in each case. The calculated value of the density of states at the Fermi energy is used to calculate the electronic contribution to the specific heat. The experimental value is 6% larger than the calculated value and if the mass enhancement of the electrons via the electron−phonon interaction is taken into account, the agreement may be regarded as satisfactory. The Fermi surface geometry of the crystal gives rise to three sheets corresponding to the three bands which cross the Fermi energy. From the geometry of the Fermi surface, the de Haas−van Alphen frequencies were calculated as a function of field direction. These results compare quite well with the experimental data. Finally, the logarithmic derivatives of the de Haas−van Alphen frequencies with respect to pressure were calculated and compared to the experimental results. The results show marked deviation from the free-electron scaling model which is also borne out by the experimental results. (auth)

42424 (IS-T-530) ELECTRICAL RESISTIVITY OF SEVERAL DILUTE ANTIFERROMAGNETIC ALLOYS OF α-MANGANESE. Williams, Willie Jr. (Ames Lab., Iowa). May 1972. Contract W-7405-eng-82. 46p. Dep. NTIS.

Electrical resistivity measurements were made on several dilute alloys of antiferromagnetic α-Mn. The measurements were made on manganese-rich Mn-Fe, Mn-Ru, Mn-Cr, and Mn-V with percentages of solute varying from 1 to 3 at. %. Since Mn, as well as Mn alloys, exhibits anomalies in the temperature dependence of the resistivity at the onset of antiferromagnetic ordering, the Nèel temperatures of the alloys were determined. The experimental results show that dissolving Fe or Ru into solute with Mn tends to raise the observed Nèel temperature, while dissolving Cr or V depresses the Nèel temperature. With the introduction of these impurity elements into α-Mn, initial rates of change in T_N of +14, +16, -14, and -20° per at. % solute were observed for Fe, Ru, Cr, and V, respectively. These results are consistent with a study by Bellau and Coles (Proc. Phys. Soc., 82: 121 (1963)) and seem to support a large spin-disorder resistance above the Nèel temperature. (auth)

42425 (NYO-4075-11) PROGRESS REPORT, MAY 1, 1971-APRIL 30, 1972. Artman, Joseph O. (Carnegie-Mellon Univ., Pittsburgh, Pa.). 12 Apr 1972. Contract AT(11-1)-3245. 7p. (COO-3245-1). Dep. NTIS.

The progress reported are the growth of Np^{4+}-doped CaF_2 crystals with and without charge compensation, optical properties of NpF_4 and the doped crystals, and questions on the valence and structure. (D.L.C.)

42426 (RLO-2221-T-6-14) SPECTROSCOPIC STUDIES OF ACTINIDE IONS IN CRYSTALLINE SOLIDS. Summary Progress Report, October 1, 1971-September 30, 1972. Gruber, John B. (Washington State Univ., Pullman). 1972. Contract AT(45-1)-2221. 16p. Dep. NTIS.

A brief account is given of several studies of the optical and magnetic properties of actinide and rare earth ions in insulators and semiconductors. Some possible laser applications of the research are listed, and the equipment used is described. 52 references. (D.L.C.)

42427 TIME-DIFFERENTIAL QUADRUPOLE INTERACTION OF ^{111}Cd NUCLEI IMPLANTED BY (α,2n) REACTIONS INTO A CUBIC Ag LATTICE. Behar, M.; Steffen, R. M. (Purdue Univ., Lafayette, Ind.). Phys. Rev. Lett.; 29: No. 2, 116-8(10 Jul 1972).

The quadrupole interaction of ^{111}Cd ions following the decay of ^{111}In implanted by (α,2n) reactions into a cubic (fcc) Ag lattice was measured with the time-differential perturbed angular correlation method. In addition to a smeared-out quadrupole interaction with a centroid frequency of $\overline{\omega}_Q \simeq 2.5$ MHz, about 10% of the implanted ^{111}Cd ions experience a unique quadrupole interaction with $\omega_Q^0 = 115$, 130, or 140 MHz, depending on the primary α beam. Annealing causes the quadrupole perturbation to vanish completely. (auth)

42428 REMOVAL OF OXYGEN IMPURITY DURING THE GROWTH OF CaF_2 SINGLE CRYSTALS. Olympios, E. M. (Democritus Nuclear Research Center, Athens). Radiat. Eff.; 14: No. 1-2, 119-21(May 1972).

Oxygen impurity from CaF_2 starting material was removed during the growth of single crystals, using CoF_2 as scavenger. The efficiency of CoF_2 was found to be greater under the specified growth conditions, than that of PbF_2. No significant selective absorption of the CoF_2-scavenged CaF_2 crystals was observed after irradiation. (auth)

42429 MAGNETIC PROPERTIES OF COBALT-SAMARIUM WITH A 24-MG Oe ENERGY PRODUCT. Foner, S. (Massachusetts Inst. of Tech., Cambridge); McNiff, E. J. Jr.; Martin, D. L.; Benz, M. G. Appl. Phys. Lett.; 20: No. 11, 447-9(1 Jun 1972).

The magnetic moment and hysteresis properties of a high-density nearly completely oriented Co_5Sm magnet alloy were measured from 300 to 4.2°K and in applied fields up to 140 kOe. A saturation moment of 98 G cm^3/g is measured at 300°K and shows a slight increase as temperature is decreased. After adjustment for voids and oxide, the saturation moment of the Co-Sm alloy is 102 G cm^3/g, or equivalent to 11,000 G for the saturation magnetization $4\pi J_s$. An energy product of approximately 24 MGOe is attained at 300°K. (auth)

42430 ELECTRICAL SWITCHING IN ANODIC OXIDE FILMS ON ZIRCALOY-2. Ramasubramanian, N. (Chalk River Nuclear Labs., Ont.). J. Electrochem. Soc.; 119: No. 5, 649-52(May 1972).

In anodic oxide films on Zircaloy-2, the second-phase particles are the sites where a majority of the bistable switchings and the associated breakdowns occur. (auth)

42431 THERMIONIC EMISSION OF AN Ir(111)-C FILM. Zandberg, E. Ya.; Tontegode, A. Ya.; Yusifov, F. K. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1920-5(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2420-7(Nov 1971).

The thermionic current and the In^+ ion current produced by surface ionization of In in an Ir(111)-C system were measured as functions of the coverage by carbon Θ at iridium temperatures from 1615 to 1785°K (current isotherms). There is a critical coverage Θ_k for each $\overline{T}$; with $\Theta < \Theta_k$, the system is homogeneous with respect to the work function φ, the carbon appears at the surface in the form of individual atoms, and φ is increased. With $\Theta > \Theta_k$, the formation of carbon particles with a reduced work function is observed; over the remainder of the surface the value of φ corresponds to Θ_k. Thus, when $\Theta > \Theta_k$, the Ir(111)-C system becomes inhomogeneous with respect to φ to $\Theta \leq 1$. When $\Theta = 1$, the system is again homogeneous and φ is smaller than $\varphi_{(111)\mathrm{Ir}}$ by about 1 V. At T = 1685°K, $\Theta_k \approx 0.2$. The structural rearrangement of the carbon coating is regarded as a type I phase transition (from the gas to the condensed state in the two-dimensional adsorbed carbon layer). (auth)

42432 WORK FUNCTION OF SINGLE CRYSTALS OF MOLYBDENUM-NIOBIUM ALLOYS. Savitskii, E. M.; Litvak, L. N.; Burov, I. V. (Metallurgy Inst., Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1929-30(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2431-2(Nov 1971).

The work function of the (111) face of single crystals of molybdenum-niobium alloys was measured in a vacuum of 10^{-9} mm Hg over the whole range of compositions; it is established that the change in work function is additive in character. An emission picture was obtained for the alloy molybdenum +42 wt % niobium with the help of thermionic emission projection. The observed anisotropy is similar to that obtained for pure metals with a bcc lattice. (auth)

42433 CRYSTAL STRUCTURES IN THE SYSTEM Zn-In-S. Gnehm, Ch.; Niggli, A. (Swiss Federal Inst. of Tech., Zurich). J. Solid State Chem.; 5: No. 1, 118-25(Jul 1972).

Crystal structures of the three nonstoichiometric compounds $Zn_{1.685}In_{2.21}S_5$, $Zn_{4.37}In_{2.42}S_8$ and $Zn_{6.13}In_{2.58}S_{10}$ were determined. Their hexagonal unit cells are of the Wurtzite type with a = 3.85 Å, the c-dimensions and space groups being 30.85 Å, $P6_3mc$; 24.96 Å, P3ml; 31.30 Å, P3ml, respectively. All atoms occupy positions on the triad rotation axes. The layer structures show the same principle as all the other known structures in the Zn-In-S system. They are based on slightly distorted close packing of the sulfur atoms with Zn in tetrahedral voids, whereas In may occupy tetrahedral and octahedral voids in the same structure. A survey of the existing Zn-In-S structures was extended to indicate all the conceivable hexagonal Zn-In-S types not yet known. (auth)

42434 ANOMALIES IN THE MICROHARDNESS OF PURE GADOLINIUM AND ITS ALLOYS WITH IRON IN THE VICINITY OF THE CURIE POINT. Nabutovskaya, O. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 12, 3130-1(Jun 1972).

Translated from Fiz. Tverd. Tela; 13: No. 12, 3705-6(Dec 1971).

An experimental study was made of the effect of adding iron (0.08, 1.0, and 1.86%) on the microhardness peaks of Gd at 292.1 and 276.9°K. In the 0.08% Fe alloy, the peaks are broadened, while in the other two alloys, splitting of the peaks occurs, with the additional maximum and minimum appearing at slightly higher temperatures. Metallographic examination shows precipitation of a new phase at the grain boundaries in the alloys. (D.L.C.)

42435 ULTRASONIC STUDY OF CRITICAL PHENOMENA IN A HOLMIUM SINGLE CRYSTAL NEAR THE NEEL POINT. Goncharov, K. V.; Mal'tseva, I. V.; Savitskii, E. M. (Moscow State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 12, 3125-7 (Jun 1972).

Translated from Fiz. Tverd. Tela; 13: No. 12, 3700-2(Dec 1971).

Absorption and velocity of ultrasound in a Ho single crystal were measured near the Neel point for wave vectors parallel to the c and a axes. The temperature dependence of the velocity and attenuation of longitudinal sound was studied at 20 MHz, and the exponents of the dependence were determined. The temperature dependence of the spin diffusion coefficient was also determined. There is no anomaly in the velocity at the Neel point for the direction parallel to the a axis. (D.L.C.)

42436 EXCHANGE INTERACTION IN RARE EARTHS INCLUDING WAVE-FUNCTION SYMMETRY. Irkhin, Yu. P.; Karpenko, V. P. (Inst. of Metal Physics, Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 12, 3027-9(Jun 1972).
Translated from Fiz. Tverd. Tela; 13: No. 12, 3586-8(Dec 1971).

The largest terms in the effective Hamiltonian for indirect exchange in rare earths are calculated by means of Racah algebra. In contrast with the previous studies, the conduction electrons are described by wave functions with an account of the point symmetry of the crystal. The splitting of the conduction-electron states in the point-symmetry crystal field is assumed much larger than the band "smearing" of these states. The results are considered to show yet another possible contribution of the exchange interaction to the magnetic anisotropy. (auth)

42437 ELECTROPHYSICAL PROPERTIES OF TRANSIENT METAL NITRIDES AT LOW TEMPERATURES. Samsonov, G. V.; Shvedova, L. K. (Inst. of Problems in Material Management, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 10, 1597-1601 (Oct 1971). (In Russian).

Temperature dependence of electrical resistivity was studied in nitrides of transient metals from groups IV–V. Concentration dependence of electrical resistivity, Hall coefficient, and susceptibility was investigated in titanium, zirconium, and vanadium nitrides. A smooth character is observed in changes of these properties within the homogeneity regions, a tendency is noticeable to an increase in electrical resistivity, Hall coefficient, and susceptibility with a deviation from stoichiometry. The physical properties studied are analyzed with application of ideas of electronic structures of the compounds. (auth)

42438 FORMATION OF ISLANDS OF COPPER ATOMS DIFFUSING OVER A MOLYBDENUM SURFACE. Abramenkov, A. D.; Seryugin, A. L.; Martynov, I. S.; Slezov, V. V.; Fogel, Ya. M. (Physical-Technical Inst., Kharkov). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 12, 2955-8(Jun 1972).
Translated from Fiz. Tverd. Tela; 13: No. 12, 3496-3500(Dec 1971).

Results are reported of the direct observation of island formation during the diffusion of copper over molybdenum, using the methods of optical and electron microscopy. In addition to providing confirmation of the general conclusions of the theory of the formation of islands of a substance diffusing over the surface of a substrate, the results obtained on the formation of copper islands on molybdenum are compared quantitatively with the conclusions arrived at by theoretical calculations. In spite of certain assumptions made for the purpose of the calculations, the agreement between the experimental and theoretical values for the size of the islands appears to be good. (auth)

42439 PHASE DIAGRAMS FOR HYDROGEN IN METALS AS DEDUCED FROM FERROELASTIC PROPERTIES. Alefeld, G. (Technische Univ., Munich). Ber. Bunsenges. Phys. Chem.; 76: No. 3-4, 355-9(Apr 1972).

Qualitative and partly quantitative arguments in favor of the interpretation that the long-range elastic dipole–dipole interaction is responsible for phase transitions of hydrogen in metals are presented. The measurement of the response of interstitially dissolved hydrogen to an applied external elastic field yield certain combinations of the components of the elastic dipole moment tensor. These combinations determine the interaction energies which are relevant for the phase transitions "condensations" and "ordering" of hydrogen. Experimental results of Gorsky-effect measurements on H in V, Nb, Ta, and Pd are discussed. (auth)

42440 MAGNETIC STRUCTURE OF $ErAg_2$. Atoji, Masao (Argonne National Lab., Ill.). J. Chem. Phys.; 57: No. 2, 851-5 (15 Jul 1972).

A neutron powder diffraction study was made of the magnetic properties of $ErAg_2$ (the tetragonal body-centered CaC_2-type structure) at temperatures between 297 and 1.5°K. At 5.2°K, the onset of an incommensurate, sinusoidal moment alignment takes place (the α structure). The α magnetization wave propagates along the a axis and the α wavelength is 6.345 Å = 1.277 a, all in the face-centered lattice description. The $x(\parallel a)$ and $y(\parallel b)$ components of the α wave amplitude are approximately equal, and the z component is essentially zero. At 3.5°K a commensurate magnetization wave starts to grow (the β structure). The β wave propagates also along the a axis and the β wavelength is equal to the a spacing. In further cooling below 3.5°K, the x component of the α amplitude decreases rapidly and diminishes completely below 1.5°K, while the y component retains its 3.5°K value down to 1.5°K. The maximum x component of the α amplitude is 5.3 μ_B at 3.5°K and the maximum y component takes the same value at 3.5 to 1.5°K. No significant variation was observed on the α wavelength at $4.8 > T > 1.5$°K. Regarding the β moment, the x component is predominantly larger than the y component and the z component is undetectably small. The β moment components follow the Brillouin-type magnetization, and the moment values extrapolated to 0°K are approximately 6 and 3 μ_B for the x and y components, respectively. The composite configuration of the α and β waves portrays an antiferromagnetic stacking of the distorted fan-type moment arrays. (auth)

42441 STUDY OF INTERACTION EFFECTS IN Au–V ALLOYS THROUGH SUSCEPTIBILITY AND SPECIFIC HEAT MEASUREMENTS. Saint-Paul, M.; Souletie, J.; Thoulouze, D.; Tissier, B. (Centre National de la Recherche Scientifique, Grenoble, France). J. Low Temp. Phys.; 7: No. 1-2, 129-39 (Apr 1972).

The magnetization M of dilute Au–V alloys of concentration varying between 0.2 and 10 at.% was measured at 4.2 K in fields up to 60 kOe. M is proportional to the field for all fields. The specific heat, measured between 0.4 and 3 K, shows a term linear in temperature γT, with $\gamma = 3.3$ and 4.6 $mJ \cdot mole^{-1} \cdot K^{-2}$ for the 5 and 10% V alloys, respectively. χ and γ increase less rapidly than the vanadium concentration. In terms of different magnetic character between isolated impurities and nearest neighbors, the analysis of the specific heat results is consistent with a drastic reduction in the d spin susceptibility of V nearest neighbors by interaction effects, contrary to the case of Au–Co, Cu–Co, Cu–Ni, and Cu–Fe where interaction effects produce an enhancement of χ. The fluctuation temperature of these two types of impurities is very different; $T_f \simeq 270$ K for isolated V atoms and $T_f \simeq 2500$ K for V nearest neighbors. The V atoms in group tend to have the same character as vanadium metal. The observed increase of the ratio $\xi = (\chi\, d\gamma/dc)/(\gamma\, d\chi/dc)$ from 0.2 for isolated atoms to 0.8 for V in group is consistent with the decrease of Hund's coupling. (auth)

42442 RELATION BETWEEN THE ANOMALOUS RESISTIVITY AND THE SUSCEPTIBILITY FOR DILUTE MAGNETIC ALLOYS. Souletie, J. (CNRS, Grenoble, France). J. Low Temp. Phys.; 7: No. 1-2, 141-56(Apr 1972).

It follows from scattering theory that the anomalous resistivity of dilute magnetic impurities may be written as $\Delta_\rho = A - B \cos 2S(\pi/5)$, where S is a temperature-dependent spin value. This relation is experimentally verified for various systems when S undergoes an almost complete compensation from S_{max} to zero. Illustrations are given with available data on Au–V, Cu–Cr, Cu–Fe, Au–Fe, Cu–Mn, Au–Co, and Cu–Ni. (auth)

42443 ENERGY STORAGE IN PHOSPHORS. Bose, H. N. (Indian Inst. of Tech., Kharagpur). pp 257-87 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).
From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

Some of the problems and results of studies on the phenomenon of energy storage in luminescent materials are reviewed. In such materials, energy storage is caused mostly through the agency of the trapping mechanisms. The salient features of the processes involved in trapping of electrons or holes and their liberation by thermal or optical stimulation, followed by recombination, are discussed here. The possible effects of trapped electrons and holes on the luminescent, absorption, dielectric, electric, magnetic and mechanical properties of phosphors are briefly reported; the possibility of utilizing such effects for understanding the electronic processes responsible for the phenomenon of energy storage and related matters are also indicated. The methods of determining the trapping parameters from the measurements of decay, thermoluminescence, and thermally stimulated conductivity are described. Some of the provoking results and outstanding problems are also pointed out to attract the attention of the research workers interested in this field. (auth)

42444 COMPRESSIBILITY OF 22 ELEMENTAL SOLIDS TO 45 KB. Vaidya, S. N.; Kennedy, G. C. (Univ. of California, Los Angeles). J. Phys. Chem. Solids; 33: No. 7, 1377-89 (Jul 1972).

The compressibility of 22 elemental solids was measured by static methods in a piston cylinder apparatus to 45 kb. In most cases agreement with the data derived by reduction of shock wave data is extremely good. In a few cases, low-pressure phase changes makes the agreement less good. In general, the new measurements of compressibility are in closer agreement with the results from shock data than with Bridgman's earlier results

(1949). The bulk moduli and some pressure derivatives were estimated by fitting a Murnaghan equation and a modified Murnaghan equation to the data points, and these results are intercompared with the results from ultrasonic measurements, from shock measurements, and from prior results of Bridgman. (auth)

42445 MAGNETIC PROPERTIES OF USSe AND USTe. Pletyushkin, V. A.; Chechernikov, V. I.; Slovyanskikh, V. K. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 5, 605-6 (Sep-Oct 1971). (In Russian).

The magnetic properties of two ternary U compounds with chalcogens were studied. The magnetic susceptibility was measured at 100 to 300°K, and from the susceptibility-temperature curves the paramagnetic Curie points and effective magnetic moments were: for USSe, 25°K and 2.92 μ; for USTe, 74°K and 2.90 μ. Lattice parameters for these and analogous compounds are tabulated. (K.S.W.)

42446 CALCULATION OF THE SPIN-LATTICE COEFFICIENTS OF Gd^{3+} IN CaO, CaF_2, ThO_2, AND CeO_2. Schlottmann, P. (Univ. Nacional de Cuyo, Bariloche, Argentina). Phys. Status Solidi (b); 51: No. 2, 913-18(1 Jun 1972).

The contributions of three mechanisms to second-order spin-lattice coefficients of Gd^{3+} in CaO, CaF_2, ThO_2, and CeO_2 are calculated with a point-charge approach for the orbit-lattice parameters. It is seen that for Gd^{3+} the Blume and Orbach mechanism does not have the importance as for the $3d^5$ ions, Mn^{2+} and Fe^{3+}. With the Blume and Orbach mechanism, a relativistic second-order mechanism, and a fourth-order mechanism, a sign agreement for both coefficients of Gd^{3+} in CaO and for the tetragonal coefficient in the other lattices is obtained, but not for the trigonal distortions. (auth)

42447 ELECTRONIC THERMAL RESISTIVITY OF CADMIUM. Toussaint, G.; Pecheur, P. (CNRS, Nancy). Phys. Status Solidi (b); 51: No. 2, K95-7(1 Jun 1972).

The Ziman-Baym theory was used to calculate the thermal resistivity of Cd parallel and perpendicular to the c-axis. The numerical calculations, plotted for the temperature range 20 to 180°K, are lower than experimental values, and the deviation from the Wiedemann-Franz law occurs in the right temperature range. The contribution of the N processes is always weaker than that of the U processes, which are strongly anisotropic. (D.L.C.)

42448 MAGNETIC PHASE TRANSITIONS IN NEODYMIUM BY PHENOMENOLOGICAL THEORY. Lehmann-Szweykowska, A. (Mickiewicz Univ., Poznan, Poland). Phys. Status Solidi (b); 51: No. 2, K139-41(1 Jun 1972).

Nd has two magnetic phase transitions (both antiferromagnetic collinear ordering with modulation in (001) planes, and subtending an angle of 60° with each other), with $T_N = 19.2$ and 7.5°K. A theory of these transitions is proposed, in which interactions with the molecular field are treated as a perturbation to ionic states in the crystal field. Numerical results indicate that the RKY functions for the distance a and c = 1.6a are of the same order of magnitude and of the same sign. Reasons for the temperature difference between the magnetic-phase transitions are discussed. (D.L.C.)

42449 ELECTRIC AND THERMAL CONDUCTIVITIES OF RARE ELEMENT METALS (HOLMIUM, ERBIUM, AND THULIUM) IN A MAGNETIC FIELD. Nikol'skii, G. S.; Evyagina, N. M. Sb. Nauch. Tr., Fiz.-Tekh. Inst. Nizh. Temp., Akad. Nauk Ukr. SSR; No. 4, 71-83(1969). (In Russian).

The behavior of the electric and thermal conductivities of Ho, Er, and Tm at low temperatures in a magnetic field was investigated. The results were used to explain changes in the energy spectra of electrons and spin waves. Measurements of the resistance to flow of heat and electricity on one sample lead to hypotheses regarding the cause of some special features of the $\Delta R/R$ (H) curves. Possible mechanisms of heat transfer in these metals are analyzed, and the anomalously large Lorenz number is believed to be associated, not with participation of spin waves as active heat carriers, but with a significant contribution of magnons. (tr-auth)

42450 ACOUSTIC PARAMAGNETIC RESONANCE OF IRRADIATED TiO_2:Cr. Boiteux, M.; Doussineau, P.; Ferry, B. (Univ., Paris). Phys. Status Solidi (b); 51: No. 2, 521-7(1 Jun 1972). (In French).

Cr-doped and γ-irradiated rutile monocrystals were studied by means of acoustical paramagnetic resonance. A part of the observed lines was ascribed to Cr^{3+} ions, and two spin-phonon coupling constants of Cr^{3+} were measured: $|G_{44}| \approx 3$ cm^{-1} and $|G_{66}| \approx 7$ cm^{-1}. The attribution of supplementary lines to Cr^{2+} Cr^{4+} ions is discussed. (auth)

42451 EPR BEHAVIOR OF THE COBALT-RARE-EARTH LAVES PHASE. Burzo, E.; Domsa, F. (Inst. for Atomic Physics, Bucharest). Phys. Status Solidi (b); 51: No. 2, K89-93(1 Jun 1972).

The temperature dependence of the reciprocal susceptibility of RCo_2 compounds follows a Niel-type variation, with the effective moment of the Co atoms being 2.00 ± 0.50 μ_B. EPR measurements were carried out on $GdCo_2$, $TbCo_2$, $DyCo_2$, $HoCo_2$, and $ErCo_2$. Except for $GdCo_2$, the resonance may be observed only within a limited temperature range around the Curie point (no resonance at all for $HoCo_2$ and $ErCo_2$). The resonance line is ascribed to rare earth ions; except for Gd, the R atoms relax rapidly. (D.L.C.)

42452 TRAPPED EXCITONS IN SOLID HYDROGEN. Gedanken, A.; Raz, B.; Jortner, J. (Tel-Aviv Univ., Israel). Chem. Phys. Lett.; 14: No. 3, 326-8(1 Jun 1972).

A vacuum-ultraviolet spectroscopic study of Wannier states of Xe impurity in solid H_2 and D_2 provides physical information on the conduction band in these solids. A large host isotope effect on the optical linewidths of the impurity states was also observed. (auth)

42453 ELECTRICAL PROPERTIES AND NON-STOICHIOMETRY OF MONOCLINIC SAMARIUM SESQUIOXIDE AT HIGH TEMPERATURES. Breuil, Helene; Dherbomex, Nicole; Wilbert, Yves (Univ., Amiens, France). Compt. Rend., Ser. C; 274: No. 13, 1282-5(27 Mar 1972). (In French).

The isothermal variations of the electrical resistance of monoclinic Sm_2O_3 were measured as a function of the partial oxygen pressure. This oxide possesses ionic and electronic conductivities of the same order of magnitude. The p-type oxide presents an electronic conductivity, due to interstitial ions, which depends upon $p_{O_2}^{+1/4}$. (France)

42454 PLASTIC DEFORMATION BEHAVIOR OF Mo SINGLE CRYSTALS UNDER COMPRESSION. Liu, G. C.; Lau, S. S.; Dorn, J. E. (Univ. of California, Berkeley). Phys. Status Solidi (a); 11: No. 2, 645-51(16 Jun 1972).

The yield stress and slip behavior of Mo single crystals in six different orientations were investigated under compression over the temperature range from 77 to 550°K. The plastic behavior shows varying degrees of reversal effects in yield stress and slip-band formation upon reversal of the sense of applied stress, depending on the crystal orientation. An attempt was made to rationalize the results in terms of the modified Peierls model. It is shown that not all experimental observations can be explained satisfactorily by the model. (auth)

42455 TEMPERATURE DEPENDENCE OF SOME PROPERTIES OF $NaTh_2(PO_4)_3$ FERROELECTRIC CRYSTALS. Topic, M. (Ruder Boskovic Inst., Zagreb); Napijalo, M.; Popovic, S.; Zeljic, Z. Phys. Status Solidi (a); 11: No. 2, 787-90(16 Jun 1972).

Measurements of the relative dielectric permittivity $\epsilon_{(100)}$ in the range from −160 up to +390°C as well as x-ray diffraction analysis from −130 up to +1050°C do not indicate any ferroelectric phase transformation in $NaTh_2(PO_4)_3$ crystals. The relation between the ferroelectric properties and the structural characteristics of compounds with the common formula $A^I B_2^{IV} (PO_4)_3$ is discussed. (auth)

42456 ANISOTROPY OF ANGULAR DISTRIBUTION OF RADIATION DUE TO POSITRON ANNIHILATION ON THE SURFACE OF Mo SINGLE CRYSTALS. Dekhtyar, I. Ya.; Silantev, V. I.; Adonkin, V. T. (Inst. of Metal Physics, Kiev). Phys. Status Solidi (a); 11: No. 2, K153-6(16 Jun 1972).

Positron annihilation was used to study the electron density distribution on the (110) and (111) faces of Mo single crystals. Angular distribution curves of the annihilation photons were obtained for negative θ angles, and they show a "fine structure", indicating a significant anisotropy of electronic states. The elements of the "fine structure" in the electron momentum distribution on the faces are tabulated. The angular distribution of volume annihilation in (110) crystals is different from that for annihilation with electrons on the surface of the (110) face. (D.L.C.)

42457 RELAXATION MEASUREMENTS ON FERROMAGNETIC RARE EARTH HYDROXIDES. Schlachetzki, A.; Eckert, J. (Yale Univ., New Haven). Phys. Status Solidi (a); 11: No. 2, 611-22(16 Jun 1972).

The trihydroxides of the rare earths Tb, Dy, and Ho are known to be ferromagnetic at liquid He temperatures. They show an extreme magnetic anisotropy. Measurements of their ac susceptibility in their real and imaginary parts from 1.5 to 700 Hz are reported. The low-field measurements reveal Cole-Cole semicircles with well-defined relaxation times, leading to activation energies of a few 10^{-3} eV. The high-field ac susceptibility shows an abrupt jump at a well-defined amplitude of the driving field. As demonstrated by switching experiments, it takes tens of minutes for the magnetization to follow a change of the dc magnetic field. The time variation of the magnetization can be approximated by a logarithmic law. It can be concluded from a phenomenological description that two different relaxation processes are observed, the first of which is thermally activated and the second one similar to a thermal after-effect. (auth)

42458 MAGNETIC PROPERTIES OF LIGHT-RARE-EARTH METALS. **Millhouse, A. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerlingen, Switzerland). Helv. Phys. Acta; 45: 5-8(1972).**

The ordered magnetic structures of heavy-rare-earth metals, as determined by neutron diffraction, are now well known. Information about magnetism in light-rare-earth metals has been lacking. During the past few years single-crystal samples of light-rare-earth metals have been investigated using neutron diffraction. The results of these investigations are discussed for Ce, Pr, Nd, Pm, Sm, and Eu. 15 references. (auth)

42459 TANTALUM THIN FILM RESISTORS. Duckworth, R. G. (Ultra Electronics Ltd., London). Thin Solid Films; 10: No. 3, 337-53(Jun 1972).

Ten years ago tantalum thin films seemed to be the ideal basis for the manufacture of specialized thin-film circuits. However, serious difficulties were experienced in providing suitable production equipment where critical circuit performance requirements had to be met. Nowadays there is a much better understanding of the conditions required to produce desirable tantalum films and the reasons for the main problems encountered in their exploitation are apparent. A number of types of tantalum-based thin film resistors are now in production that successfully fulfil the original expectations of performance. This review attempts to outline these various developments, while illustrating some of the problems associated with the manufacture of thin-film layers with well-defined properties. 36 references. (auth)

42460 STRUCTURES AND RESISTIVE PROPERTIES OF SPUTTERED Ti–Zr–Al–N THIN FILMS. Wasa, Kiyotaka; Hayakawa, Shigeru (Matsushita Electric Industrial Co., Ltd., Osaka). Thin Solid Films; 10: No. 3, 367-75(Jun 1972).

Mixed nitride films of a Ti–Zr–Al–N system were prepared by cathodic sputtering from a composite Ti–Zr–Al cathode in a nitriding atmosphere. The structure and electrical conduction of the mixed nitride films are similar to the well-known cermets, metal–dielectric mixtures, with a ternary nitride of Ti–Zr–N as the metallic conductor and Al–N as the dielectric. The resistivity of the mixed nitride films is much higher than that of Ti–N and ranges from 600 to 7800 $\mu\Omega$ cm with $\alpha < \pm 200$ ppm/°C. These sputtered films have a potential in the production of thin-film precision resistors in a wide range of resistivity with high electrical stability, and for hybrid circuit elements for microelectronics. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 40998 and 42451.

42461 PROGRESS IN NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY. VOLUME 8, PART 1. Emsley, J. W.; Feeney, J.; Sutcliffe, L. H. (eds.). Elmsford, N. Y.; Pergamon Publishing Company (1971). 107p. $5.75.

Separate abstracts were prepared for the 2 included sections. (M.O.W.)

For abstracts of individual sections see: 42462 and 42463.

42462 NARROWING OF NMR SPECTRA OF SOLIDS BY HIGH-SPEED SPECIMEN ROTATION AND THE RESOLUTION OF CHEMICAL SHIFT AND SPIN MULTIPLET STRUCTURES FOR SOLIDS. Andrew, E. R. (Univ. of Nottingham, Eng.). Progr. Nucl. Magn. Resonance Spectrosc.; 8: Pt. 1, 1-39 (1971).

The essential theory of the effect of specimen rotation on the NMR spectra of solids is given. Other areas described are the following: techniques for achieving high-speed rotation rates, the relationship of the method to other methods of spectral narrowing, limitations of the method and of the resolution attainable, and relaxation effects. (M.O.W.)

42463 PULSED NMR IN SOLIDS. **Mansfield, P. (Univ. of Nottingham, Eng.). Progr. Nucl. Magn. Resonance Spectrosc.; 8: Pt. 1, 41-101(1971).**

The single pulse response theory is briefly reviewed in terms of the Hamiltonian and Liouville representations. Some of the early double-pulse solid echo experiments are discussed as well as the more recent in-phase multiple-pulse experiments. The modification and application of multiple techniques to the resolution of isotropic and anisotropic chemical shifts, Knight shifts, and electron-coupled nuclear spin interactions in solids are described. The effect of spin–lattice interactions on pulse experiments is discussed. (M.O.W.)

42464 PROGRESS IN NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY. VOLUME 8, PART 2. Emsley, J. W.; Feeney, J.; Sutcliffe, L. H. (eds.). Elmsford, N. Y.; Pergamon Publishing Company (1971). 65p. $5.00.

A literature review is given of ^{13}CH satellite NMR spectra and ^{13}C resonance spectroscopy. Coverage is believed to be reasonably complete to the end of 1969. (M.O.W.)

42465 ^{73}Ge 13.3-keV MOESSBAUER EFFECT WITH ^{73}Ga PARENT PRODUCED BY PHOTONUCLEAR REACTION ^{74}Ge(γ,p) ^{73}Ga IN GERMANIUM LATTICE. Matsui, Keiji (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 4: No. 2, 93-100(Feb 1972).

The Moessbauer effect of the ^{73}Ge 13.3-keV E2 $(5^+/2-9^+/2)$ transition was detected in germanium single crystals using the photonuclear reaction ^{74}Ge(γ,p)^{73}Ga. These crystals were bombarded by 50-MeV linac electrons, whose bremsstrahlung induced the reaction. The Moessbauer measurements were made in scattering geometry to detect the internally converted 9.89-keV Ge K x rays in order to avoid the very high conversion coefficient difficulty. A series of spectra, though not satisfactory in resolution, was observed in an Sb-doped n-type crystal in which the primary electron damage was annealed out. The spectra at 293°K showed substantial line broadenings irrespective of the scatterers employed. These spectra were tentatively fitted by quadrupolar multiplet lines. The fits with $Q_{9/2}/Q_{5/2} = \pm 0.25$ seem the best, with $q = \pm 1.3 \times 10^{16}$ cgs in agreement with $|q| = (4/5)\ e\ \langle r^{-3} \rangle = 1.5 \times 10^{16}$ cgs in which $\langle r^{-3} \rangle = 38.8 \times 10^{24}$ cm^{-3} from spectroscopic data of the various defect models that would fit these electric field gradient values, a plausible one would be an interstitial germanium Ge(i)$^{+1}$/4s^{2}4p^1 migrating rapidly in the lattice after its production by the 1.2-MeV β recoil of ^{73}Ga. The interstitial exhibits the $q = -(4/5)\ e\ \langle r^{-3} \rangle$ multiplet and a singlet, at hexagonal and tetrahedral interstitial sites, respectively. An analysis based on this model suggests the hexagonal site preference and a migration energy lower than 0.1 eV for the interstitial. (auth) (Japan)

42466 MIGRATING, TRAPPED, AND CONVERTED INTERSTITIALS IN GERMANIUM MONITORED BY MOESSBAUER EFFECT OF ^{73}Ge. **Matsui, Keiji (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 4: No. 2, 101-15(Feb 1972).**

A discussion is given of the ^{73}Ge 13.3-keV Moessbauer spectra in germanium and other diamond-lattice semiconductors, for use in the study of radiation damage in these materials. A simple crystal-field treatment of the two interstitial sites in germanium shows that a large quadrupole splitting appears from an electron on the p_0 orbital at the hexagonal site, while the spectra associated with the tetrahedral site remain singlet. An interstitial Ge^{+1} (4s^{2}4p^1) is likely to migrate with very low energy to develop the two kinds of spectra alternatively. The charge state, crystal-field configuration, lattice polarization, recoil anisotropy, migration energy, and time-of-visit can be determined from the Moessbauer measurements. Studies on other charge states are also possible. The giant splitting formalism applied to p-electron orbitals of interstitials trapped at charged centers shows in a similar way the possibilities of detailed microscopic identification of the paired structures. Study of vacancy viewed from ^{73}Ge at a nearest-neighbor site is also possible. A simple LCAO treatment indicates the relations of narrow-line transition. It is to be noteworthy that the effect has advantages over EPR when dynamical information is required. The transition is especially adapted to the study of interstitials, but the study of vacancies is also possible. Interstitials in germanium and silicon have been poorly understood. An extensive study of the ^{73}Ge Moessbauer effect in germanium would be a shortcut to settle the disputes on "the difference" of these materials, and to push forward the basic understanding of radiation effects in semiconductors. (auth) (Japan)

PHYSICS (THEORETICAL)

Refer also to abstracts 42024 and 42246.

42467 (ITF-71-121-E) NORMAL STATES ON ALGEBRAS OF UNBOUNDED OPERATORS. Lassner, G.; Timmermann, W. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 16p. Dep. NTIS (U. S. Sales Only).

The problem of the normality of positive functionals on algebras of unbounded operators is investigated. Conditions are formulated under which the normal states are uniformly continuous, and the normality of any uniformly continuous state on the maximal Op($\mathcal{H}$)-algebras on certain unitary spaces is proven. (auth)

42468 NON-HERMITIAN HAMILTONIANS, DECAYING STATES, AND PERTURBATION THEORY. Sternheim, Morton M. (Los Alamos Scientific Lab., N. Mex.); Walker, James F. Phys. Rev., C; 6: No. 1, 114-21(Jul 1972).

The conventional time-independent perturbation theory and projection-operator techniques are generalized to systems propagating under the influence of an effective non-Hermitian Hamiltonian, e.g., an optical-model potential. The mathematical complications which can arise due to lack of orthogonality and completeness for the eigenstates of such a Hamiltonian are discussed on an elementary level. Examples of the various techniques involved are taken from considerations of models for exotic atoms and cascade processes. (auth)

42469 THERMODYNAMIC GREEN'S FUNCTION FOR HARTREE–FOCK HAMILTONIAN. Lee, Koo Chul. New Phys. (S. Korea); 11: No. 4, 157-61(Dec 1971). (In Korean).

Thermodynamic Green's functions for the Hartree–Fock Hamiltonian which is defined by a diagonal part of the Hamiltonian in $\{n_k\}$ representation, the occupation numbers of the momentum state k, are computed exactly. The self-energy modification beyond Hartree–Fock terms is found to vanish in the thermodynamic limit. Thermodynamic quantities derivable from the exact Green's functions are the same, in the thermodynamic limit, with the results, commonly called the Hartree–Fock approximation. (auth)

42470 HYPERVIRIAL RELATIONS AS CONSTRAINTS IN THE HARTREE–FOCK APPROXIMATION WITH APPLICATION TO A SYSTEM OF COUPLED HARMONIC OSCILLATORS. Bjoernaa, N. (Univ. of Oslo). Phys. Norv.; 4: No. 3-4, 223-39 (1970).

The effect of introducing hypervirial relations as constraints into the Hartree–Fock approximation is discussed. The discussion is followed by an application to the ground state of a system which consists of two particles of spin $^1/_2$ moving in a common harmonic-oscillator potential and interacting through the same kind of potential. In this example the constrained Hartree–Fock problem, with appropriate hypervirial relations as constraints, can be solved exactly, and so can the ordinary, unconstrained Hartree–Fock problem as well as the Schrödinger equation, whereby the analysis of the effect of constraining is rendered fairly simple. The restriction on the hypervirial generator for an exact, bound- and stationary-state eigenfunction to satisfy a definite hypervirial relation is discussed. Examples are given in which this restriction is of consequence. It is proved that the ordinary Hartree–Fock wave function satisfies any hypervirial relation generated by a one-particle operator or by a sum of such operators. (auth)

42471 GREEN FUNCTION OF THE FREE ELECTRON IN A UNIFORM MAGNETIC FIELD. Gountaroulis, G. (Univ. of Patras, Greece). Phys. Lett.; 40A: No. 2, 132-4(3 Jul 1972).

The Green function of the free electron in a uniform magnetic field is exactly calculated, first by use of the Schrauben functions and second by the method of Wannier functions in a magnetic field. (auth)

42472 SIMPLE PROOF FOR A BASIC LINKED CLUSTER THEOREM. Ubbink, J. T. Ark. Fys. Seminar Trondheim; No. 7, 1-13(1972).

For a system of interacting fermions a functional is defined from which both the Green functions and the vacuum expectation value of the evolution operator can be obtained. On the basis of the Ursell cluster expansion a linked cluster theorem is proved for this functional. From this basic theorem other linked cluster theorems are derived. (auth)

42473 SIMPLIFIED VERSION OF THE RANDOM-PHASE APPROXIMATION AND THE PROBLEM OF THE CORRELATION ENERGY OF A MANY-FERMION SYSTEM. da Providencia, J. (Univ., Coimbra). Port. Phys.; 5: No. 4, 125-38(1969-1970).

A discrepancy between the formula for the correlation energy of a many-fermion system derived by the conventional random phase approximation (RPA) method and the corresponding expression derived by summation of perturbation theory bubble diagrams is investigated. It is shown that this discrepancy is absent from a simplified version of the RPA dealing only with collective excitations. As an example, the new version of the RPA is applied, with good results, to the electron gas. (auth)

42474 PROCEEDINGS OF THE SIXTH BERKELEY SYMPOSIUM ON MATHEMATICAL STATISTICS AND PROBABILITY. VOLUME I. THEORY OF STATISTICS. Conference Held at Berkeley, California, June 21–July 18, 1970. Le Cam, Lucien M.; Neyman, Jerzy; Scott, Elizabeth L. (eds.). Berkeley, Calif.; University of California Press (1972). 771p. $28.50. (CONF-700668–(Vol.1)).

The conference covers the general theory, sequential analysis, asymptotic theory, nonparametric procedures, and regression and multivariate analyses. (J.F.P.)

REACTOR TECHNOLOGY

Power Reactor Development

Refer also to abstracts 40826 and 41491.

42475 NUCLEAR REACTORS. Ackroyd, Ronald Tunstal; Perks, Maurice Arthur (to United Kingdom Atomic Energy Authority). U. S. Patent 3,660,227. 2 May 1972. Priority date 15 Nov 1968, Great Britain.

A core configuration for a liquid metal cooled fast breeder nuclear reactor includes a generally cylindrical breeder region, a first fissile region which completely embraces the central breeder region, a second fissile region wholly or partially surrounding said first fissile region with axial and radial clearance, an inner breeder region occupying said clearance, and an outer breeder region extending from the outer boundary of the second fissile region to the boundary of the core itself, which is generally cylindrical. A variation envisages the second fissile region only partially surrounding the first fissile region, the "corner" portions being occupied by breeder material in place of the fissile material of a completely embracing second fissile region. (Official Gazette)

42476 NUCLEAR POWER IS THE BASIC TREND IN DEVELOPMENT OF FUTURE POWER ENGINEERING. Ermakov, G. V. Therm. Eng. (USSR) (Engl. Transl.); 18: No. 4, 10-17(1971).

Translated from Teploenergetika; 18: No. 4, 6-11(1971).

The development trends of nuclear power in the Soviet Union are surveyed. The design and performance characteristics of PWR type reactors, water-cooled graphite-moderated reactors, and fast reactors are examined. Nuclear power station economics, district heating plants, and improvements in equipment are discussed. (H.D.R.)

42477 REAKTORTAGUNG, BONN, 30. MARZ–2. APRIL, 1971. TAGUNGSBERICHT. (Reactor Meeting, Bonn, March 30–April 2, 1971. Meeting Report). Bonn; Deutsches Atomforum E. V. (1971). 831p. (In German and English). (CONF-710346). ZAED.

Included are 196 summaries of papers on nuclear reactor development. A separate abstract was prepared for each of 193 papers. Three papers were previously abstracted for NSA. (H.D.R.)

For abstracts of individual papers see: 40591, 40722, 40723, 40742–40750, 40780, 40781, 40816, 40907, 41003–41005, 41352–41359, 41374, 41375, 41396, 41397, 41440, 41441, 41459, 41460, 41470, 41481–41483, 41488, 42105, 42106, 42141, 42403–42405, 42478, 42479, 42481–42494, 42496–42500, 42502, 42503, 42507–42522, 42524–42543, 42545, 42546, 42549–42552, 42554–42559, 42562–42580, 42582, 42590–42614, 42619–42644, and 42646–42650.

42478 KNK-II: DESIGN AND STATE OF THE PROJECT. Marth, W. (Kernforschungszentrum, Karlsruhe, Ger.); Stoehr, K. W.; Andrae, H. pp 754-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Some typical properties of the design of the core are given, which will be used for the testing of decisive parameters of the SNR fuel elements. Moreover it is reported on safety features, the advantage for the German fast breeder development and the time schedule for KNK-I and KNK-II. (INIS)

42479 SYSTEM CONCEPT, SAFETY, AND ECONOMICS OF THE GAS-COOLED FAST BREEDER REACTOR. Preuss, H. J. (Siemens AG, Erlangen, Ger.); Goetzmann, C. A.; Vollmer, H.; Foerster, S. pp 778-81 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

An account is given of the results of the efforts in the working groups "components", "safety" and "economics" covered by the gas breeder memorandum 1969 and 1970. (INIS)

Physics and Core Engineering

Refer also to abstract 40907.

42480 DETERMINATION OF THE DYNAMIC CHARACTERISTICS OF FUEL CELLS. Morozov, I. I.; Kaz'min, V. P. This paper was summarized in At. Energ. (USSR); 30: No. 6, 534(Jun 1971) as paper No. 497/5493. (In Russian).

Full copy of this paper is held by TIC.

Investigations of the stability of operation of boiling reactors and steam generators of nuclear energy installations give evidence that non-equilibrium processes in the walls of the fuel channels can substantially influence the position of the limit of stability, the value of the required choking, etc. The influence of heat exchange on the reactor stability is expressed by the equation of the energy balance, while the value of the fluctuation of the thermal flux in this equation depends on a certain complex quantity, considering the thermal inertia of the wall and expressing its dynamic characteristics. An experimental method is proposed for determining the frequency characteristics of the wall of the heater, which is illustrated with a tubular fuel cell as an example. The essence of the method consists of studying the harmonic oscillations of the consumption and measuring the temperature fluctuations of the liquid (and, consequently, the fluctuations of the thermal flux). The set of points $|\delta q| / |\delta \dot{G}|$, considering the phase shift, represents one of the frequency characteristics of the wall of the heater, with a knowledge of which all the remainder can be determined. Investigations of a tubular fuel cell indicated satisfactory agreement between the calculated and experimental frequency characteristics and the practical possibility of their determination. (auth)

42481 POLCA: A THREE-DIMENSIONAL BWR SIMULATOR. Lindgren, P.; Edvinsson, R.; Lundmark, B. (ASEA–ATOM, Vaesteras, Sweden). pp 42-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Following the explanation of the computing procedure in POLCA, a description is given of the various possibilities of using this system for the calculation of dynamic reactor data. (INIS)

42482 DETERMINATION OF EFFECTIVE CROSS SECTIONS OF FISSION PRODUCTS FOR FAST BREEDERS BY INTEGRAL MEASUREMENTS. Bustraan, M.; Coehoorn, J.; Dragt, J. B.; Heyboer, R. J. (Reactor Centrum Nederland, Petten). pp 94-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

In the central fast zone of the STEK facility at Petten, the effective cross sections of a great number of fission products are determined from central reactivity worth measurements, using an oscillator technique. All details of the measurements are given. (INIS)

42483 REACTIVITY EFFECTS OF CAVITIES IN SODIUM-COOLED FAST REACTORS. Stojadinovic, A.; Voss, J.; Wehmann, U. (INTERATOM, Bensberg, Ger.). pp 102-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The result of a comparison of calculation methods was that one-dimensional diffusion computation shows a good estimation of the upper limit of the positive reactivity effect of spherical cavities. Furthermore a description is given of the determination of the reactivity effect in a parameter study for the SNR and in SNEAK experiments. (INIS)

42484 CHECK OF A THREE-DIMENSIONAL SYNTHESIS CODE WITH DIRECT METHOD AND EXPERIMENTS. Pilate, S. (Societe Belge pour l'Industrie Nucleaire, Brussels); Buckel, G. pp 106-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The computer program KASY solves the three-dimensional diffusion equation by means of a synthesis method using available two-dimensional fluxes. The results obtained by KASY, k(eff), reactivity difference and maps of the fluxes and fission rates, were compared with those from a direct three-dimensional program, TRITON. Typical fast breeder cores have been considered, with or without control rods, fully or partially inserted in a central or an off-center position. Furthermore, the KASY synthesis techniques was applied to the evaluation of two diversified series of control rod experiments performed in SNEAK. (INIS)

42485 DETERMINATION OF β_{eff} IN FAST REACTORS. Boehme, R.; Fisher, E. A.; Korthaus, E. (Kernforschungs-

zentrum, Karlsruhe, Ger.). pp 114-17 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).
From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Criticism is voiced about former inexact results (large overestimation) of the determination of main reactivity worths for plutonium cores. This is followed by the description of experiments for the determination of the delayed neutron fraction at SNEAK. First results are given. (INIS)

42486 ANALYSIS OF SEFOR EXPERIMENTS. Wintzer, D.; Bogensberger, H. G. (Kernforschungszentrum, Karlsruhe, Ger.). pp 118-21 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).
From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Reactivity calculations were made, followed by the determination of the radial fission ratio distribution and of the reactivity worth of a fuel pin in different radial positions. (INIS)

42487 THERMODYNAMIC CORE CALCULATION OF PEBBLE BED REACTORS. Schuermeyer, H.; Weicht, U. (Brown Boveri/Krupp Reaktorbau GmbH, Cologne). pp 138-41 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).
From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A short explanation of the most important processes in the THIR pebble bed reactor is followed by the description of the method for the thermodynamic calculation of the mass flow. The calculation method used is verified by a comparison between calculated and measured heat-transfer coefficients. (INIS)

42488 CALCULATION AND MEASUREMENT OF THE TRANSVERSE MASS FLUX BETWEEN PARALLEL SUBCHANNELS. Stiefel, Ulrich (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). pp 146-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).
From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A theoretical and experimental investigation was performed on the mass transfer between subchannels of a fuel element bundle for gas-cooled fast breeder reactors. A computer code CLUHET has been developed that takes into account the heat and mass transfer between neighboring subchannels more satisfactorily than existing codes. Furthermore, it has been studied experimentally in what manner the pressure difference and the mass flux distribution depend on the variations of the flow resistance and on perturbations in one subchannel. The calculation method chosen shows satisfactory agreement with the measurements, also for the range of high transverse velocities. (INIS)

42489 FLOW DISTRIBUTION IN THE REGION OF LOCAL COOLING CHANNEL BLOCKAGES IN FUEL ROD ELEMENTS. Kirsch, D.; Meyder, R.; Schultheiss, G. F. (Kernforschungszentrum, Karlsruhe, Ger.). pp 150-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).
From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The flow behaviour in the region of cooling channel blockages has been studied in order to find out what temperatures are to be expected in the critical zones, i.e., in the dead water behind the blockage. First investigations are described that aimed at measuring the extension and volume of the dead water and of the mass flow between dead water and normal flow. From these values, the mean temperature of the coolant in the dead water region can be calculated. (INIS)

42490 INVESTIGATIONS CONCERNING THE VALUE AND THE SUGGESTIBILITY OF THE TEMPERATURE COEFFICIENT IN HIGH TEMPERATURE REACTORS. Bonka, H. (Technische Hochschule, Aachen). pp 166-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).
From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The reason for the positive temperature coefficient in a HTGR furnished with low enriched uranium is studied. Methods are specified to reduce the temperature coefficient (e.g., reduction of the moderator temperature coefficient). (INIS)

42491 MEASUREMENT AND INTERPRETATION OF THE COOLANT-VOID COEFFICIENT IN D_2O LATTICES. Hage, W.; Hettinger, H.; Hohmann, H.; Sturm, B.; Toselli, F. (GFS-EURATOM, Ispra, Italy). pp 174-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).
From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Within the scope of the D_2O-reactor program of the European Community the reactor ECO was used for measurements of the void coefficient of uranium dioxide fuel elements. The test conditions and the measuring methods are described, followed by an analysis of the experimental results. The calculations were based on the supposition of a homogenous void distribution. (INIS)

42492 ANDYCAP: A THREE-DIMENSIONAL COMPUTER PROGRAM FOR TRANSIENT ANALYSIS OF BOILING WATER REACTORS. Babala, D. (ASEA-ATOM, Vaesteraas, Sweden); Bech, N.; Haugset, K.; Thingvold, Oe.; Poern, K. pp 238-40 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971).
From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

After representation of the physical model the interaction methods are described. (INIS)

42493 QUANTITATIVE NUMERICAL ANALYSIS OF FREE AND CONTROLLED XENON-OSCILLATIONS IN TWO DIMENSIONS IN HIGH TEMPERATURE REACTORS. Lauer, A. (Kernforschungsanlage, Juelich, Ger.). pp 253-6 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).
From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Investigations are described of the spatial power oscillations in multi-region cores, influenced by xenon-poisoning and external control provisions. A flexible programming system was prepared for these investigations. (INIS)

42494 LOAD CYCLE BEHAVIOR AND CYCLE PERIOD FLEXIBILITY OF NUCLEAR POWER PLANTS FURNISHED WITH H_2O-MODERATED PRESSURIZED WATER REACTORS. Boehm, W. (Siemens AG, Erlangen, Ger.); Kollmar, W.; Janssen, U. pp 292-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).
From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A description is given of the investigation of 3 ways of reactivity control of pressurized water reactors during load alterations, e.g., control by: (1) movable control rods (neutron absorbers), (2) boric acid dissolved in the coolant, (3) changes in the coolant temperature. The results of the calculations and experiments show a flexible behavior of this reactor type, both with regard to extreme power requirements and to alterations of operating periods. (INIS)

Control and Instrumentation

42495 USE OF ACOUSTIC AND OPTICAL METHODS TO DETECT BOILING IN NUCLEAR REACTORS. Bonnet, Juan Amedee Jr. Ann Arbor, Mich.; Univ. of Michigan (1971). 105p. University Microfilms Order No. 72-14,811.
Thesis.

A new technique to monitor boiling in nuclear reactors is considered. The technique could also be used to study two-phase single-component fluid behavior. The new technique consists of the introduction of acoustic waves in the core and measuring the deviations in the neutron or gamma population as boiling occurs. The acoustic wave causes pressure disturbances in the fluid, changing the fluid density which consequently changes the neutron density and fission rate. The neutron or gamma density is measured, squared, time averaged, and compared with the same quantity without an acoustic wave. It is shown that, under some conditions, this ratio is very sensitive to the initiation of boiling. This is due to the fact that a small number of bubbles increases the mean compressibility of the mixture appreciably. It is demonstrated that this method seems to be relatively more promising for monitoring boiling in sodium-cooled fast reactors than in water-thermal reactors. The magnitude of the signal in both types of reactors is small; but it may be measurable—especially in the case of the fast reactors. It is also proposed that two optical techniques, that are currently being used in other fields, may be adapted to study two-phase behavior of fluids, and/or monitor the initiation of boiling in pressurized-water reactors. The methods are based on: (1) the introduction of electromagnetic (optical or infrared) radiation in the core, from a laser source, and observing the Brillouin scattering of light as boiling occurs, and (2) the observation of changes in the fringe pattern produced by an optical interferometer located in the coolant fluid to sense when boiling occurs. (Diss. Abstr. Int., B)

42496 RELIABILITY INVESTIGATIONS ON TWO SHUTDOWN SYSTEMS FOR A HELIUM-COOLED HTR. Gnutzmann, H.; Heim, H.; Schulz-Heyn, H. J. (Brown Boveri/Krupp Reaktorbau GmbH, Cologne). pp 367-70 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Investigations were conducted: (1) to assess the order of reliabilities of two control rod drives, including their power supply; (2) to find the component groups or subsystems with the highest relative failure expectance in order to take measures for the improvement of the system reliability; (3) to define the influence of the constructions under consideration on the availability of a large nuclear power plant (300 MW(e)). (INIS)

42497 NEUTRON FLUX MEASUREMENT WITH THE ALTERNATING CURRENT CHANNEL. Stimler, M. (AEG-Telefunken, Frankfurt am Main). pp 371-4 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Based on the Campbell noise theory and on the cross correlation principle, an ac channel has been constructed. It consists of a conventional fission chamber provided with specially developed electronics. (INIS)

42498 DEVELOPMENT OF CORE INSTRUMENTATION OF PRESSURIZED WATER REACTORS. Gruener, W. (Siemens AG, Erlangen, Ger.); von Haebler, D.; Klar, E.; Hofmann, W. pp 375-8 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The measuring system working with spheres has been further developed so that all spheres, each for itself, can be measured simultaneously after activation. Fission chambers (BWR) spherical (n,β)-detectors are not suitable. But (n,β)-detectors in cable form show a high sensitivity. (INIS)

42499 METHOD FOR THE QUICK DETECTION AND LOCALIZATION OF FUEL CAN DAMAGES IN SODIUM-COOLED FAST REACTORS. Gast, K. (Kernforschungszentrum, Karlsruhe, Ger.). pp 383-6 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The principle of the cyclone separator is applied. The fission gases escaping after a rupture in the canning tube are separated from the coolant in the outlet channel of the fuel element by means of a gas separator and are accumulated to a coherent gas column. The fission gas is detected by an electrically heated temperature probe which signals a rapid temperature rise as soon as it is surrounded by gas instead of Na and thus is no longer cooled. The detection time is 1 sec. The fuel element in question is localized simultaneously with the can rupture detection. (INIS)

42500 APPLICATIONS OF DIRECT DIGITAL CONTROL AT THE OECD HALDEN BOILING WATER REACTOR. Blomsnes, B. (Institutt for Atomenergi, Halden, Norway). pp 514-17 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The application of a Direct Digital Control (DDC) on the reactor Halden is illustrated by some characteristic examples. (INIS)

Containment Systems, Waste Processing, and Radiation Protection

42501 (JAPFNR-21) STUDY OF METHODS FOR THE RESONANCE ABSORPTION CALCULATION IN A FAST REACTOR. II. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa Prefecture (Japan)). Translation of report PNC-J-201-71-1, 76p. Dep. NTIS (U. S. Sales Only).

Microscopic cross section libraries were prepared for nuclides ^{235}U and ^{240}Pu in the same way done for ^{238}U and ^{239}Pu in the first part of this study. Level parameters used mainly came from (1) Schmidt's compilation and Kikuchi's spin-dependent Γ_f^J for ^{235}U and (2) Petrel bomb experiment reported by Byers et al., as well as experiments conducted at Geel for ^{240}Pu, and experimental cross section data for both nuclides were reproduced fairly well by a random sampling procedure (in the unresolved region). Mutual shielding effects on effective cross section σ and Doppler cross section $\Delta\sigma$ are calculated both numerically, solving the slowing-down equation directly, and semi-analytically, following Rowland's and Froelich's expansions, for combinations ^{239}Pu-^{238}U and ^{239}Pu-^{240}Pu, and the semi-analytical method of Rowlands was found to give almost the same results as the numerical calculation. Heterogeneity effect on σ and $\Delta\sigma$ of ^{240}Pu was also calculated numerically for a prototype fast reactor MONJU and was found to be a little smaller than that on σ and $\Delta\sigma$ of ^{238}U reported previously. The mutual shielding and heterogeneity effects on effective multiplication factor k and Doppler coefficient dk/dT of MONJU were negligibly small. 19 references. (auth)

42502 RESULTS OF EXPERIMENTAL INVESTIGATIONS OF PRESSURE SUPPRESSION OF WATER-COOLED REACTORS. Ruediger, B.; Zimmermann, M. (Battelle-Institut eV, Frankfurt am Main). pp 261-4 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Results of preliminary tests using a small glass pressure vessel and of main tests using steel containers of different heights for the study of thermodynamic and fluidmechanic processes are discussed. (INIS)

42503 NONSTEADY PRESSURES IN REACTOR CONTAINMENT VESSELS. COMPARISON BETWEEN THEORY AND EXPERIMENT. Brosche, D. (Technische Univ., Munich). pp 265-8 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

With the program ZOCO V the transient pressures of containment vessels and pressure suppression systems of LWR's in case of loss-of-coolant accidents are calculated. The pressure patterns are tested experimentally. (INIS)

Coolant System

Refer also to abstract 40990.

42504 INVESTIGATING THE PROCESS OF FISSION PRODUCT BUILDUP IN THE PRIMARY LOOP OF A WATER-MODERATED WATER-COOLED POWER REACTOR. Mironov, V. N.; Teplov, P. V.; Kazakov, V. A. Therm. Eng. (USSR) (Engl. Transl.); 18: No. 4, 51-3(1971).

Translated from Teploenergetika; 18: No. 4, 34-6(1971).

Equations are presented for calculating the emission of fission products from fuel elements to the coolant and their buildup in the primary loop of water cooled reactors. Results of calculations on the loop contamination by ^{95}Zr and ^{144}Ce are compared with measured data. (H.D.R.)

42505 SETTING STANDARDS FOR STEAM GENERATOR FEED CONDITIONS IN NUCLEAR STATIONS WITH WATER-MODERATED WATER-COOLED POWER REACTORS. Margulova, T. Kh.; Zorin, V. M.; Kyun, G. Yu. (Moscow Power Inst.). Therm. Eng. (USSR) (Engl. Transl.); 18: No. 4, 34-40(1971).

Translated from Teploenergetika; 18: No. 4, 23-8(1971).

The operating conditions of double-loop nuclear power plant steam generators are described. Formation and removal of chloride-ion and SiO_2 impurities in the steam generator water are discussed, and recommended values for water standards in PWR-type reactors are presented. (H.D.R.)

42506 WAYS OF INCREASING UNIT CAPACITY OF STEAM GENERATORS OF NUCLEAR POWER STATIONS WITH PRESSURISED WATER COOLED REACTORS. Turetskii, L. I.; Galetskii, N. S.; Pis'man, B. Ya. Therm. Eng. (USSR) (Engl. Transl.); 18: No. 4, 18-22(1971).

Translated from Teploenergetika; 18: No. 4, 12-14(1971).

The limitations on the unit capacity of steam generators transportable by rail are examined. The effects of the length of heat transfer tubes, their diameter, material, etc., on the steam generator characteristics are described. The potential for increasing the capacity of Soviet type steam generators is discussed. (H.D.R.)

42507 IMPROVEMENTS IN THE DYNAMIC DESIGN OF BOILING WATER REACTOR NUCLEAR POWER PLANTS. Reinhardt, A.; Braeuhaeuser, H.; Colmano, G. (AEG-Telefunken, Frankfurt am Main). pp 241-4 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The function of the safety valves attached to the primary system and the improvements in the deviation system are described. Moreover, some new ideas concerning reactor stability and system noise are discussed. (INIS)

42508 TRANSIENT RESPONSE OF NUCLEAR POWER PLANTS FURNISHED WITH PRESSURIZED WATER REACTORS IN THE CASE OF BREAKDOWN OF THE MAIN COOLANT PUMPS. Friedmann, P.; Frei, G. (Siemens AG, Erlangen, Ger.). pp 245-8 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Various disturbances have been calculated with the help of a digital computing program using the simulation language ANAGOL for the process including or excluding the throw-in of the control rods. Using the example of the reactor Stade, it is shown that the breakdown of 1 or 2 main coolant pumps can be controlled and compensated without reaching shut-down limits. (INIS)

42509 THERMAL INSULATION SYSTEMS FOR PRESTRESSED CONCRETE VESSELS OF HIGH TEMPERATURE GAS REACTORS. Aranovitch, E.; Crutzen, S.; Dufresne, J.; Farfaletti-Casali, F. (EURATOM-CCR, Ispra, Italy). pp 315-18 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Design of a novel patented insulation concept, depressurization tests, thermal tests, mathematical codes for heat transfer calculations in rectangular insulation cells are described. (INIS)

42510 FABRICATION OF LARGE PRESSURE VESSELS FOR BOILING WATER REACTORS. Heidt, K.; Lohse, K. H.; Ullrich, W. (AEG-Telefunken, Frankfurt am Main). pp 319-22 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The various steps of fabrication are referred to and special attention is given to the most essential aspects: design, calculation, material, construction (cylindrical part, bottom parts, insitu welding), and testing. (INIS)

42511 EMBRITTLEMENT ANALYSIS OF THE REACTOR PRESSURE VESSEL DURING EMERGENCY CORE COOLING. Bartholome, G. (Siemens AG, Erlangen, Ger.). pp 323-6 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The stress of the thermal shock during emergency core cooling is investigated using fracture mechanics. The analysis comprises only the cylindrical vessel wall because only here a neutron embrittlement of the material can occur. (INIS)

42512 INVESTIGATIONS CONCERNING HEAT EXCHANGERS COMPOSED OF HELICALLY COILED TUBES FOR STEAM GENERATORS OF GAS-COOLED NUCLEAR POWER PLANTS. Groehn, H. G.; Scholz, F.; Tuerk, G. (Kernforschungsanlage, Juelich, Ger.). pp 331-4 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A description is given of the construction and advantages of coiled heat exchangers, as well as of the test program and its results. The investigations were concentrated on the internal part of a coiled steam generator which was tested under conditions as similar as possible to actual operating conditions in the high-pressure gas channel under pressures up to 40 bar and temperatures up to 300°C. Heat transfer and pressure drop were investigated as well as temperature and velocity profile. (INIS)

42513 DIGITAL DYNAMIC DISTURBANCE SIMULATION FOR THE STEAM GENERATOR SYSTEM OF THE SNR. Evers, H. O. (INTERATOM, Bensberg, Ger.). pp 336-8 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A multi-zone model is presented for parallel current and countercurrent devices. The extreme disturbance is a scram-down of total plant from full-load state, with two coolant circuits cut off and a blocking pump. Evidence exists for a sufficient and stable natural circulation in the Na circuits, even under tertiary cooling conditions. (INIS)

42514 MODIFICATION OF THE DESIGN OF INTERMEDIATE HEAT EXCHANGERS OF SODIUM-COOLED REACTORS USING FERRITIC MATERIALS. Schnauder, H.; Mueller, R. A. (Kernforschungszentrum, Karlsruhe, Ger.). pp 339-42 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The results of a comparative investigation are reported which demonstrates the technical feasibility of a change from austenitic materials to ferritic materials for the purpose of cost reductions. The investigations were made on a sodium /sodium-intermediate heat exchanger which is a representative component of the total cycle. (INIS)

42515 CALCULATIONS OF THE PRESSURE FORMATION IN COMPRESSIBLE AGENTS DURING Na–H_2O REACTIONS. Huebner, R.; Schnitker, W. (INTERATOM, Bensberg, Ger.). pp 343-6 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The formation of pressure variations in the system is shown by calculation (program HEINKO) and experiment. A description is given of the mathematic-physical procedure to solve similar problems using the applied programs HEINKO (hydrodynamic switching processes in tube systems filled with compressible agents). (INIS)

42516 POSSIBILITIES OF CONTROLLING INTEGRATED COOLANT GAS BLOWERS IN HTR REACTORS WITH HIGH POWER. Amelong, G.; Cramer, H.; Hagstotz, G. (Brown Boveri/Krupp Reaktorbau GmbH, Mannheim, Ger.). pp 363-6 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A report is given on various concepts of a throughput variation and of the energy supply of the coolant gas blowers, considering control and drive systems with variable speed and constant speed of the blower. A decision in favor of one best solution is still pending because of lack of operating experience. (INIS)

42517 DETERMINATION OF OXYGEN CONCENTRATION IN SODIUM LOOPS. Borgstedt, H. U.; Drechsler, G.; Frees, G.; Schneider, Helga; Wittig, G. (Kernforschungszentrum, Karlsruhe, Ger.). pp 379-82 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

In connection with corrosion studies in sodium loops several methods of oxygen analysis have been tested: (a) indirect volumetric and flame-photometric determination of oxygen in the Na_2O residue of a sodium distillation; (b) oxygen determination from the distribution equilibrium of sodium and vanadium; (c) on-line measurement with an electrochemical probe; (d) determination of the point of oxygen saturation for sodium with the plugging meter. (INIS)

42518 STATUS OF THE SODIUM MEASURING TECHNOLOGY IN GERMANY. Hans, R.; Lauhoff, T.; Schmidt, K. (INTERATOM, Bensberg, Ger.). pp 395-8 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Status of development of level, temperature, pressure and flow rate measuring devices for in-line control of sodium plants is discussed. (INIS)

42519 INVESTIGATION OF THE CARBON DEPOSITION ON HTR STEAM GENERATOR MATERIALS AND OF THE DIFFUSION OF HYDROGEN THROUGH SUCH MATERIALS. Serpekian, T. (Kernforschungsanlage, Juelich, Ger.). pp 403-6 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The carbon deposition from carbon monoxide upon the coolant-loop-faced steam generator tubes in high-temperature reactors on the one hand, and the metal oxidation by water and steam inside the tubes on the other, as well as the mutual influence of the two reactions have been studied in long-time experiments in a testing-stand using different materials. In particular the influence of hydrogen has been of interest which is generated in the metal oxidation process in the tubes and which diffuses through the walls as atomic hydrogen and finally gets into the primary coolant loop. (INIS)

42520 EXPERIENCE FROM THE EMPLOYMENT OF REMOTE-HANDLED ULTRASONIC AND TELEVISION INSTALLATIONS FOR THE INSPECTION OF REACTOR PRESSURE VESSELS. Meyer, H.-J. (Maschinenfabrik Augsburg-Nuernberg AG, Nuremberg); Feldmann, J.; Grabendoerfer, W. pp 524-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The possibilities and limits of both techniques for re-inspections of pressure vessels and their components are evaluated. (INIS)

42521 INHERENT PROPERTIES OF THE VARIOUS PRIMARY CIRCUIT DESIGNS OF SODIUM-COOLED REACTORS. Mueller, R. A. (Kernforschungszentrum, Karlsruhe, Ger.). pp 733-6 of

Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

An analysis of the fundamental structure of the primary circuit of sodium-cooled reactors is presented. On the basis of a general description found by abstraction additional parameters are introduced stepwise so that the variants under consideration approach the real engineered designs. The method yields a consistent scheme comprising all possible variants up to a defined degree of refinement. (INIS)

42522 GAS COOLING OF FAST BREEDER REACTORS. Wirtz, K. (Kernforschungszentrum, Karlsruhe, Ger.). pp 770-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Three different variants of this reactor type are described. The particularities and advances of the gas-cooled type are explained in comparison to the sodium-cooled breeder reactor. (INIS)

Fuels and Fuel Elements

42523 STUDY OF THE SHELL THERMAL STRESS DISTRIBUTION IN A LOOSE KERNEL TYPE OF SPHERICAL FUEL ELEMENT FOR A PEBBLE BED REACTOR. Whatham, J. F.; Hawker, P. A. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nucl. Eng. Des.; 21: No. 1, 114-25(1972).

The results are given of a study of the temperature and stress distributions on the surface of a spherical fuel element consisting of a BeO shell with a detached heat-generating kernel lying eccentrically (under gravity) on the shell wall and with CO_2 in the clearance space. Cooling of the outer surface of the shell is assumed to be uniform and the effects of variations in fuel element dimensions, material properties and cooling rate are examined. The effects of a non-uniform distribution of surface heat transfer coefficient are investigated, the distribution having axial symmetry about the common center line of kernel and shell. Eccentricity of the kernel with respect to the shell substantially increases the maximum shell stress compared with that produced by a concentric kernel. However, the loose kernel fuel element compares favorably with one having the shell (or coat) bonded to the kernel. Nevertheless it is likely that in a pebble bed reactor the influence of other balls in contact on the variation of surface heat transfer coefficient would have an overriding effect on the shell stresses. (8 references) (auth)

42524 EXPERIMENTAL DETERMINATION OF BURN UP AND HEAVY ISOTOPE CONTENT IN A BWR FUEL ASSEMBLY AND COMPARISON WITH BURN UP CALCULATIONS. Koch, L. (EURATOM, Karlsruhe, Ger.); Cricchio, A.; Ariema, A.; Paoletti, M.; Zaffiro, B. pp 543-6 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Post-irradiation examinations were made in order to ascertain the capabilities of predictive calculations. A BWR fuel assembly was subjected to an extensive post-irradiation analysis, the results of which were compared with those obtained by different burnup codes. Especially calculations for burnup and heavy isotope distribution of individual rods of the assembly had to be verified. (INIS)

42525 STRAIN ON FUEL ROD CANS IN PRESSURIZED WATER REACTORS. Aisch, F. W.; Fuchs, H. P.; Holzer, R. (Siemens AG, Erlangen, Ger.). pp 554-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The fuel rod power of rods exposed to different operating conditions is considered. The mechanical strain on the fuel cans and their strength criteria are discussed. (INIS)

42526 EXPERIENCE WITH THE TEST FUEL ELEMENTS OF THE HDR. Garzarolli, F.; Rutsch, F.; Uhde, W. (AEG-Kernenergieversuchsanlage, Grosswelzheim, Ger.). pp 566-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The fuel elements developed for the HDR contain UO_2 fuel powder brought between two concentric cans by means of vibration. The external can was made of material No. 4981, or of Zircaloy-2, and for the internal can Inconel-625 was used. The experience gained during the investigation of the mechanical strain and the strength properties of the cans and weldings are outlined, as well as the corrosion and fuel behavior and the general irradiation behavior. (INIS)

42527 POST-IRRADIATION STUDIES OF SNR-PROTOTYPE FUEL RODS OF A SEVEN-ROD BUNDLE. Geithoff, D. (Kernforschungszentrum, Karlsruhe, Ger.). pp 586-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Fuel rods developed for the SNR have been irradiated in Mol (Belgium) in the reactor BR2, namely in the central sodium loop provided with a cadmium shielding for the simulation of a fast flux. The results of the destructive post-irradiation examination (gas analysis, Xe/Kr ratio, cesium migration) and of measurement studies (diameter variances) are given. (INIS)

42528 CREEP BUCKLING AND INFLUENCE OF SPACER WIRES DURING IRRADIATION OF DSR TEST ELEMENTS. von Jan, R.; Uhde, W. (AEG-Kernenergieversuchsanlage, Grosswelzheim, Ger.). pp 590-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Six fuel test elements developed for a steam-cooled fast reactor have been irradiated by an AEG team with the purpose of investigating and testing the concept of a free-standing cladding, with special regard to the creep buckling behavior and to the cladding material Inconel 625 and Incoloy 800 under DSR-"hot spot"-temperatures. A detailed account of post-irradiation investigations of a single fuel rod D_3 is presented. Irradiation of this rod had to be stopped at 65,000 MWd/t-M due to cladding defects. The investigations include integral gamma scanning of the rod, analysis of creep buckling, swelling and diameter measurements, bending, and helical distortion of fuel rod due to spacer wires. (INIS)

42529 DEVELOPMENT AND DESIGN OF THE KNK-II FUEL ELEMENTS. Andrae, H.; Mayer, H.; Wenk, K. H. (INTERATOM, Bensberg, Ger.). pp 594-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The fuel element and fuel rod design of test elements developed for the KNK-II is described. (INIS)

42530 CONSIDERING THE CARBIDE FUEL ELEMENT OF A HIGH-POWER BREEDER REACTOR, WITH REFERENCE TO SOME FUEL ROD VARIANTS. Plitz, H.; Fiedler, H.; Rehn, H.; Senski, G. (AEG-Kernenergieversuchsanlage, Grosswelzheim, Ger.). pp 598-601 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

In order to achieve an attractive high-power breeder reactor, the highest possible values for specific power, smear density and burnup must be envisaged. This is why carbide suggests itself as an appropriate fuel material for high-power breeder reactors. Various fuel rod concepts using carbide as fuel have been investigated (e.g., those with sodium bond in fuel-to-cladding gap or with helium bond), and a number of parameter calculations have been made with varying rod diameter, swelling rate, central temperature and desired burnup level. Further work includes the investigation of spacers, fuel element boxes, thermal distortions and the swelling of structural components with regard to a core optimization. (INIS)

42531 ADVANCES IN THE FABRICATION OF FUEL ELEMENTS FOR THE THTR REACTOR. Hackstein, K. G.; Herrmann, F. J.; Huschka, H.; Vygen, P. (Nuklear-Chemie und -Metallurgie GmbH, Wolfgang, Ger.). pp 618-21 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The pressed spherical graphite fuel element for the THTR reactor which corresponds basically to that of the AVR reactor has to withstand markedly more demanding operating conditions, which gave rise to the need for further development work on these fuel elements. The improvements made with regard to the manufacture of uncoated oxide fuel particles, the coating of these particles and the fabrication of spherical fuel elements, using a new kind of graphite matrix are described. (INIS)

42532 IRRADIATION TESTING ON FUEL ELEMENTS FOR THE THTR. Aumueller, L. (Nuklear-Chemie und -Metallurgie

GmbH, Wolfgang, Ger.); Balthesen, E.; Krug, W.; Ragoss, H.; Roellig, K. pp 622-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Semi-isostatically molded spherical fuel elements developed for the THTR-300 have been irradiated since 1967, first in the Dragon reactor and later in the test reactor R2. Parallel to this, another 25,000 molded spherical elements have been subjected to irradiation since 1969 in the AVR. The aim of these irradiation tests is to prove that the following properties of the fuel elements will remain unaltered under maximum core load: mechanical resistance, stability of element dimensions, and retentive ability of coatings and shells with respect to fission products. Therefore, the test conditions chosen were very much those of future real operating conditions in a THTR. (INIS)

42533 CRITERIA FOR THE DISCRIMINATION OF DEFECTS IN FUEL OR FISSION-GAS SECTIONS OF REACTOR FUEL ELEMENTS. Golly, W.; Jacobi, S. (Kernforschungszentrum, Karlsruhe, Ger.). pp 722-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A steam cycle has been installed in the FR2 for the detection of fuel element cladding failures as a means of testing a burst can detection system especially developed for steam-cooled reactors, and in order to investigate the effect of various fuel element defects. The measurement equipment and the behavior of HDR (superheated steam reactor) test fuel elements have been studied by various experiments. The fuel, vibrated UO_2 powder containing 3.15% ^{235}U, yielded a power of 514 kW at a flux of 2×10^{13} neutrons/cm^2. Experiments have been made for power and steam pressure changes. The several power increasing and pressure decreasing operations led to the definition of a number of criteria for the discrimination of defects either in the fuel or in the fission-gas sections of the elements which can be discerned by means of the counting rate. (INIS)

42534 HEAT TRANSFER FROM FUEL TO CLADDING IN FUEL PINS DESIGNED FOR SODIUM-COOLED FAST BREEDER REACTORS. Schad, O. (AEG-Telefunken, Grosswelzheim, Ger.). pp 726-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The main features of the fuel rods planned to be used in sodium-cooled fast breeder prototype reactors are (Pu)U oxide as fuel, non-vented fuel, austenitic steel cladding and helium gas as heat transfer medium. The heat transfer efficiency of such a fuel rod is limited in the hot channel not only by the thermal conductivity of the various materials but also by the temperature difference in the fuel-to-clad clearance. This difference is shown to be dependent on the coefficient of heat transmission in the gap. The conditions governing the areas of contact between fuel and cladding are changing during irradiation. The main characteristics of these zones and the heat transfer curve are demonstrated as a function of the burn-up. (INIS)

42535 PHYSICAL AND ECONOMICAL PROPERTIES OF CARBIDE FUELED BREEDER REACTORS FURNISHED WITH SODIUM- OR HELIUM-BOND FUEL PINS. Reinke, P.; Lill, G.; Ebeling, W. (AEG-Telefunken, Grosswelzheim, Ger.). pp 737-40 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The results of an investigation of the dynamic behavior of fuel pins containing carbide fuel are given. Especially the swelling ratio and the temperature characteristics were investigated. The economic advantage of the sodium bonding is shown by means of a fuel cycle cost optimization. (INIS)

42536 FUEL ELEMENT, CORE DESIGN OF GAS-COOLED FAST BREEDER REACTORS. Dalle Donne, M. (Kernforschungszentrum, Karlsruhe, Ger.); Amendola, A.; Dienst, W.; (and others). pp 774-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Computer calculations were made for different reactor concepts of the gas-cooled fast breeder reactor type to obtain nuclear data. A description is given of the technical design of core and rod-type fuel elements. The state of the coated particle concept is described. (INIS)

Auxiliary Systems and Engineered Safeguards

42537 FUNCTION AND EFFICIENCY OF EMERGENCY CORE COOLING OF NUCLEAR POWER PLANTS WITH PRESSURIZED WATER REACTORS. Winkler, F. (Siemens AG, Erlangen, Ger.). pp 269-72 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A brief description is presented of the ECCS developed by Siemens AG for 4-loop plants. Analytical investigations of the accident course and of the efficiency of the ECCS using digital computer programs are described. (INIS)

42538 MANIPULATING INSTALLATIONS FOR SODIUM-COOLED NUCLEAR POWER PLANTS. Kirchner, G.; Jansing, W. (INTERATOM, Bensberg, Ger.). pp 347-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The most essential manipulating installations for the KNK have been tested under Na in the Na large-scale pilot plant of INTERATOM. A similar program for the SNR components in the RSB has been initiated. (INIS)

42539 CLEANING OF SODIUM-WETTED COMPONENTS IN SODIUM-COOLED REACTORS. Schwarzin, K.; Neeb, H. (INTERATOM, Bensberg, Ger.). pp 350-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The possibilities of cleaning sodium-wetted reactor components are discussed. In particular, methods and equipment for wet-gas cleaning and distillation are described. Results of test series with both methods are given. (INIS)

Operation and Economics

42540 PRACTICE-ORIENTED FUEL ELEMENT CHARGING PLANNING IN NUCLEAR POWER PLANTS FURNISHED WITH LIGHT WATER REACTORS. Etzel, W.; Pekarek, H.; Roth, E. (Kraftwerk Union AG, Erlangen, Ger.). pp 449-52 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The most important limiting quantities with regard to fuel element displacement, such as load factor, burn-up and its functions as well as the background of base load operation, load flexibility and stretch-out operation are explained. The first fuel element displacement in the nuclear power plant Obrigheim is described as an example of a flexible fuel element charging planning. (INIS)

42541 RE-INSPECTION TESTS ON PRESSURIZED WATER REACTORS. EXPERIENCE DURING FUEL ELEMENT CHANGE AND CONSEQUENCES, CONSIDERED FROM THE MANUFACTURER'S VIEWPOINT. Hagen, Hans Guenter; Orth, Karlheinz (Siemens AG, Erlangen, Ger.). pp 457-60 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Testing procedures and technical devices are discussed using the pressure vessel as an example. The most important experience gained during fuel element change and re-inspections in the KWO are given. (INIS)

42542 OPERATING BEHAVIOR OF BOILING WATER REACTORS. Engel, H.; Moeller, M. (AEG-Telefunken, Frankfurt am Main). pp 465-8 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A summary is given of the experience gained with and the problems connected with the German boiling water reactors. Availability and shut-down reasons are reported in particular. Moreover, various proposals for improvements are made. (INIS)

42543 ANALYSIS OF PRESENT AND FUTURE FUEL CYCLE COSTS OF LIGHT-WATER REACTORS. Hausmann, T.; Schmiedel, P. (Kraftwerk Union AG, Erlangen, Ger.). pp 666-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Fuel cycle costs encompass all expenses directly associated with the fuel needed for power reactors. These include: expenses for natural uranium, enrichment and fuel element production, expenditure on fuel reprocessing, including all services required in this connection, revenues out of unused uranium and of plutonium produced by conversion, costs of the fuel elements needed for the operation of reactors. A cost analysis is given for a PWR and a BWR, stating the various categories of expenditure. (INIS)

Safety and Siting

Refer also to abstract 42581.

42544 CURRENT STATUS OF RESEARCH ON LOSS-OF-COOLANT ACCIDENTS IN LIGHT WATER POWER REACTORS AT JAERI-ROSA PROGRAM. Shimamune, Hiroji; Shiba, Masayoshi (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 14: No. 5, 231-40(May 1972). (In Japanese).

Current status of research on loss-of-coolant accidents in light water reactors undertaken at the Japan Atomic Energy Research Institute is extensively reviewed and discussed. The purpose of the program, the experimental facility, and the progress made during the first year after completion of the facility are described. (13 references) (auth)

42545 COMPARISON OF THE SAFETY OF SODIUM BREEDERS WITH CARBIDE OR OXIDE FUEL ELEMENTS. Ernst, H. (AEG-Telefunken, Grosswelzheim, Ger.). pp 257-60 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Fast breeders in the range of 1000 MW(e) are compared with the AEG program NUSYS. Characteristics of the reference fuel elements are for carbide fission gas pressure suppression and Na formation, and for oxide fission gas retention and gas bonding. Carbide breeders show no significant differences to those with oxide fuel in the operational and disturbance behavior in spite of higher power density and faster time behavior. The higher Na loss reactivity is offset by a lower destruction potential of the carbide breeder. (INIS)

42546 ENVIRONMENTAL EXPOSURE FROM A SODIUM-COOLED FAST BREEDER POWER PLANT. Schikarski, W.; Wild, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 502-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Discussed are: activity release during normal operation (atmosphere, coolant water), during accidental disturbances, and environmental exposure during normal operation from thermal strain on waters. It is concluded that in all cases the fast breeder represents a lower environmental exposure than LWR's. (INIS)

Steam and Power Conversion System

Refer also to abstract 40748.

42547 KhTGZ SATURATED-STEAM TURBINES FOR NUCLEAR POWER STATIONS. Savvin, V. N.; Kosyak, Yu. F.; Panshin, B. M.; (and others) (Kharkov Turbine Plant). Therm. Eng. (USSR) (Engl. Transl.); 18: No. 4, 23-33(1971).

Translated from Teploenergetika; 18: No. 4, 15-23(1971).

The design and performance features of steam turbines manufactured by the Kar'kov Turbine Plant (KhTGZ) are presented. (H.D.R.)

42548 OPTIMISATION OF THE PARAMETERS OF THE REHEATER AND OF VACUUM DOWNSTREAM OF THE TURBINE FOR A NUCLEAR POWER STATION OPERATING ON SATURATED STEAM. Arsen'ev, Yu. D.; Moskvicheva, G. A. Therm. Eng. (USSR) (Engl. Transl.); 18: No. 4, 41-5(1971).

Translated from Teploenergetika; 18: No. 4, 28-31(1971).

The effects of steam reheat and pressure drop parameters on the economics of steam turbines in water cooled reactors are analyzed. (H.D.R.)

42549 APPLICATION OF SELF-ACTUATED INSULATION VALVES IN NUCLEAR POWER PLANTS WITH BOILING WATER REACTORS. Seemann, L. (AEG-Telefunken, Frankfurt am Main). pp 355-8 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The task of these valves, after rupture of the steam pipings leading to the reactor-turbine, is to stop within a very short time the discharge of active steam into the atmosphere. A prototype of the new valve has been constructed and successfully tested. (INIS)

42550 INVESTIGATIONS FOR EVALUATING THE CONTAMINATION OF A NUCLEAR DIRECT-CYCLE DRIVEN 1000 MW SUPERHEATED STEAM TURBINE. Henzel, N. (AEG-Telefunken, Grosswelzheim, Ger.); Ammentorp-Schmidt, F. pp 532-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Fundamentals are presented for the evaluation of contamination of a superheated large steam turbine in dependence of admission time and activity throughput. Experiments in the VAK test loop are described. (INIS)

Commercial Power Reactors

42551 PREPARATION OF A PYROCARBON-COATED REACTOR GRAPHITE. Engelmann, A.; Hochegger, G.; Reiser, P.-L.; Vohler, O. (SIGRI Elektrographit GmbH, Meitingen, Ger.). pp 411-14 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The development of a method for the deposition of pyrolytic carbon in pores and on surfaces of graphite components of the KKN-reactor is described. Optimum conditions (temperature, pressure, gas-flow rate) for the deposition by thermal decomposition of propane have been found and applied to the impregnation of graphite conduit tubes. The decrease in pore volume resulting from the pyrocarbon deposition leads to a remarkably improved radiation stability of the tubes. (INIS)

42552 300 MWe THTR NUCLEAR POWER STATION. Baust, E. (Brown Boveri/Krupp Reaktorbau GmbH, Cologne); Oehme, H.; Wittchow, G.; Thurnher, K. pp 745-8 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The first German prototype high temperature nuclear power plant, provided with a pebble bed reactor, which will be constructed in Ventrop/NRW, is described. The following subjects are dealt with: parties to the contract, contract, timing, licensing procedure in accordance with nuclear law, design and construction, prices, costs, and financing. (INIS)

Physics and Core Engineering

42553 THREE-DIMENSIONAL-COMPUTER SIMULATION STUDIES OF TARAPUR POWER REACTOR OPERATION: CORE PHYSICS. Veeraraghavan, N.; Narayanan, S. Sankara; Paul, O. P. K. (Bhabha Atomic Research Centre, Trombay, India). pp 145-67 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

An attempt is made to simulate the operating core conditions of the Tarapur power reactor with a view to study the coupled effects of coolant flow, power and steam voids on the core reactivity and power distribution. Details regarding a "three dimensional and two neutron velocity groups" analysis employed in a computer program—TAPPS 23—developed for the purpose, are given. The results of these studies are compared with available design data for certain operating conditions of the core. (auth)

42554 ELABORATION OF THE FUEL ELEMENT REARRANGEMENT PLAN FOR THE FIRST FUEL ELEMENT DISPLACEMENT AND RESTART MEASUREMENTS IN THE NUCLEAR POWER STATION OBRIGHEIM. Dernedde, I.; Gruen, A. E. (Siemens AG, Erlangen, Ger.). pp 186-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A description is given of the rearrangement planning with regard to an advantageous power density distribution. Measurements were made of the form factors of the power density distribution before and after the fuel element refueling, just as of the hot channel factor and the critical boron concentration. Moreover, a comparison was made of experimental and theoretical reactor physics data obtained on the occasion of the start-up of the reactor, and before and after the first fuel element displacement, respectively. (INIS)

42555 GAMMA SPECTROSCOPIC INVESTIGATIONS ON FUEL ELEMENTS OF THE KWL NUCLEAR POWER STATION. Melchior, K. (AEG-Telefunken, Frankfurt am Main); Off, G.; Knoth, J.; Schwenke, H. pp 198-201 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

During the shutdown of the KWL, gamma scanning of the fuel elements has been performed in order to determine the power distribution existing during the last operational phase of the reactor, with control rods fully driven out. The gamma activity of each fission product corresponds to the power distribution if it has reached its steady-state concentration within this time. ^{140}La has been chosen as an appropriate nuclide, Ge(Li) as a detector. (INIS)

42556 XENON INVESTIGATIONS WITH REGARD TO THE BOILING WATER REACTOR. Schmidt, U. (AEG Kernenergieanlagen, Frankfurt am Main). pp 202-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The explanation of the computing program AXEMO is followed by a description of the Xe-effects. Various Xe-experiments are recalculated which have been carried out in the KWL. An interpretation is given of the alteration of the power density distribution caused by Xe-variations. It is possible to control the effects by a suitable control rod drive program. (INIS)

Control and Instrumentation

42557 INVESTIGATIONS CONCERNING THE DYNAMIC BEHAVIOR OF THE THTR NUCLEAR POWER PLANT. Bogorinski, P.; Breitenfelder, R.; Friedrich, K.; Massimo, L.; Infuehr, E. (Brown Boveri/Krupp Reaktorbau GmbH, Cologne). pp 249-52 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

By the aid of mathematical methods transient responses of all the controlled systems are calculated. Particularly the steam generator is considered. It is shown that one can rely on the whole on a good controlling function of the plant. (INIS)

42558 PROCESS-CONTROL COMPUTER IN THE NUCLEAR POWER STATION GUNDREMMINGEN. Heger, Herren; Pieper, W.; Tripp, H. (Kernkraftwerk RWE-Bayernwerk GmbH, Gundremmingen, Ger. AEG-Telefunken, Frankfurt am Main). pp 506-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The explanation of the tasks of the process-control computer is followed by a description of the technical substance and the arrangement of hardware and software. Remarks on analog and digital input are included. (INIS)

42559 EXPERIENCES IN THE KRB WITH THE EMPLOYMENT OF A PROCESS-CONTROL COMPUTER FOR THE CHARACTERIZATION OF THE REACTOR CORE. Gross, M.; Wolff, U. (AEG-Telefunken, Frankfurt am Main). pp 510-13 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A description is given of the applied programs and of the priority structure followed by an explanation of the calculation of the power distribution. (INIS)

Coolant System

42560 DETERMINATION OF LIMITING CAPACITY OF EVAPORATING CHANNELS IN THE REACTORS OF BELOYARSK NUCLEAR POWER STATION. Smolin, V. N. Therm. Eng. (USSR) (Engl. Transl.); 18: No. 6, 47-53(1971).

Translated from Teploenergetika; 18: No. 6, 33-7(1971).

Investigations were carried out on tubes with a nonuniform heat release over the length. It was found that the local values of critical heat fluxes differ from values obtained on tubes with a uniform distribution of heat release. The experiments were carried out on tubes 2.5 m long and 8 mm in diameter with linear increase and decrease in heat release over the outlet end of the tubes, 400 mm long. Heat flux in the outlet cross section of the tube differed from the heat flux of the uniformly heated part of the tube by factors of 1.5, 2 and 3. The experiments were carried out over the range of pressures from 78 to 176 bar, mass velocities from 1600 to 4000 kg/(m^2·s) and at heat fluxes up to 4 MW/m^2. (8 references) (auth)

42561 EXPERIENCE OF THE START-UP, OPERATION, AND FIRST INSPECTION OF THE STEAM GENERATORS AT OBRIGHEIM NUCLEAR POWER STATION. Schenk, H.; Mayr, A.; Pickel, E. Mitt. Ver. Grosskesselbetr.; 51: No. 3, 175-81 (Jun 1971). (In German).

Technical data for the steam generator are presented and the materials used are listed. These are SA 336 ASME 123A or 23 NiMoCr 36 for the water chambers and tube bottoms, Inconel 600 for tube cladding, HSB 50 S for the casing, and alloy steel for cladding the water chambers and for the water separator. Initial operating experience with the generator is outlined and details of the various modifications and replacements made during the first years of service are discussed. From results of the first inspection it is concluded that the generator has performed satisfactorily. (Metals Abstr.)

42562 COOLANT ACTIVITIES AND THEIR TIME BEHAVIOR AT SHUTDOWN OF KWO. Neeb, K. H. (Siemens AG, Erlangen, Ger.). pp 461-4 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Activity changes have been studied radiochemically and by γ-spectroscopy during the shutdown process prior to the fuel element change. (INIS)

42563 SOLID FISSION PRODUCTS IN THE PRIMARY LOOP OF A HIGH-TEMPERATURE REACTOR, MEASUREMENTS AT AVR. Lange, G. (Brown Boveri/Krupp Reaktorbau GmbH, Juelich, Ger.); Walter, K. H.; Mehrens, H.; (and others). pp 486-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The fission products ^{89}Sr, ^{90}Sr, ^{131}I, ^{137}Cs, ^{140}Ba, ^{141}Ce, ^{144}Ce and the activation products ^{46}Sc, ^{51}Cr, ^{59}Fe, ^{60}Co, ^{65}Zn, ^{134}Cs deposited on coolant gas conducting parts and in the coolant gas have been measured. (INIS)

Fuels and Fuel Elements

42564 EXPERIENCE CONCERNING THE HANDLING OF SPHERICAL FUEL ELEMENTS. Gilli, R.; Hobrecker, P.; Buelling, H. (Arbeitsgemeinschaft Versuchsreaktor GmbH, Duesseldorf). pp 482-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A description is given of the guideways for the spheres in the AVR. Disturbances, their reasons, and the possibilities of eliminating such disturbances are discussed. The largest disturbance up to now, for the elimination of which about five weeks were needed, is described in detail. (INIS)

42565 POOL-INSPECTION AND POST-IRRADIATION STUDIES OF PRIMARY FUEL ELEMENTS OF THE BOILING WATER REACTORS KRB AND KWL. Fricke, W.; Bergemann, W.; Diez, W.; Garzarolli, F.; Guse, K. (AEG-Telefunken, Frankfurt am Main). pp 551-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

After an average burnup of 5000 MWd/t it was deduced from the rate of fission product release that fuel can damage had occurred. Defective bundles were ascertained by the so-called sipping-test. The defective rods were removed and subjected to post-irradiation studies by which the local hydrogenation behavior was examined. (INIS)

42566 OPERATING BEHAVIOR OF KWO FUEL ELEMENTS. Schenk, H.; Riedel, E. (Kernkraftwerk Obrigheim GmbH, Ger.). pp 562-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A survey is given of the behavior of the KWO fuel elements. Behavior of the excess reactivity during the first and second operating cycle, arrangement of fuel elements in the first and second core, the decrease of boron concentration as a function of the medium burnup, axial burnup distribution, relative axial power density distribution, and activity behavior in the primary cooling agent are discussed. The inspection of the replaced fuel elements through the wet-sipping-test is described. (INIS)

42567 IRRADIATION BEHAVIOR OF THE FUEL ELEMENTS IN THE AVR. Ivens, G. (Arbeitsgemeinschaft Versuchs-Reaktor GmbH, Duesseldorf); Nieder, R.; Ragoss, H.; Wimmers, M. pp 626-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The methods of investigating the irradiation behavior of the AVR fuel elements are outlined. The first method is described to comprise the determination of fission noble gas release in the reactor core by continuous measurement of the total beta activity of the cooling gas, and by taking gamma spectra at regular intervals. An attempt is made to offer an acceptable interpretation of the constant decrease in activity which has been observed. As for the second method, i.e., the post-irradiation analysis of the spheres themselves, about 200 fuel elements have been taken out of the AVR and subjected to the following procedures: optical examination of surfaces, determination of fission gas release, resistance to breaking, oxidation stability, and metallographic investigations. (INIS)

Operation and Economics

Refer also to abstract 42541.

42568 REACTOR PHYSICAL DESCRIPTION OF THE INLET PHASE OF THE AVR BY MEANS OF THE MODEL AVR-70. Wagemann, R. (Arbeitsgemeinschaft Versuchs-Reaktor GmbH, Duesseldorf). pp 190-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

AVR-70 is a computer code for the simulation of the inlet phase of the AVR reactor. A description of the code is given. The operation time of the AVR reactor up to the present is used as a test interval. The results of the calculations confirm the good simulation possibilities of this code. (INIS)

42569 LOAD OPERATION OF A BOILING WATER REACTOR WITH LOWERED SYSTEM PRESSURE. Kraemer, W. (AEG-Telefunken, Frankfurt am Main). pp 470-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A 12 hour test showed that a BWR (KWL) can be operated in the power range even with considerably lowered system pressure. The limiting conditions for the power plant components and the reactor stability were determined. It was shown that the flexibility of the boiling water reactor is larger than is presently utilized. (INIS)

42570 MZFR FROM TODAY'S POINT OF VIEW. Eitz, A. W. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.); Rauber, A. pp 490-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Construction and operating experience with the MZFR are reported. (INIS)

42571 OPERATION OF THE MZFR KARLSRUHE. Olles, Th.; Armbruster, H.; Wechselberger, E. (Kernkraftwerk-Betriebsgesellschaft mbH, Leopoldshafen, Ger.). pp 494-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The functions of and the operational experience gained with the MZFR are reported, with particular reference to operation disturbances. (INIS)

42572 REDUCTION OF THE FUEL CONSUMPTION COSTS OF D_2O REACTORS AS, FOR INSTANCE, THE MZFR. Rauber, A. (Kraftwerk Union AG, Erlangen, Ger.); Eitz, A. W.; Ritz, H. pp 498-501 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

It is shown that an improvement of economics could be reached either by reducing the costs of the core or by increasing the burnup. A description is given of the tests regarding the variation of the parameters which are essential for an optimization. An optimum replacement plan for the fuel elements is described. (INIS)

42573 FUEL ELEMENT DISPLACEMENT AND REPETITION TESTS AT KWO. Mayr, A.; Schenk, H.; Boeger, G.; Pickel, E.; Spangenberg, K. H. pp 528-31 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The nuclear power plant Obrigheim was shutdown according to plan at 8-8-1970, for fuel element displacement. A description is given of the inspection tests made on this occasion. (INIS)

Safety and Siting

Refer also to abstract 41268.

42574 BEHAVIOR OF AVR REACTOR AT SIMULATED DISTURBANCES. Knuefer, H.; Dering, W.; Halfenberg, H.-W. (Arbeitsgemeinschaft Versuchsreaktor GmbH, Duesseldorf). pp 478-81 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Reactor safety is evaluated for the following disturbances: blower failure, scram, one-rod clamping test, four-rod clamping test. (INIS)

Propulsion and Auxiliary Power Reactors

42575 TEMPERATURE COEFFICIENTS CONCERNING THE INCORE-THERMIONIC REACTOR. Lutz, D. (Univ., Stuttgart); Brestrich, I.; Dagbjartsson, S.; Faber, C.; Henssen, H. pp 170-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The characteristics are given of the temperature coefficients of the driver region, the thermionic region, individual layers of the TI-cell, as well as of those of the fuel in the thermionic region. (INIS)

42576 ADVANCES IN MULTIPLE-INPUT, MULTIPLE-OUTPUT STATE VARIABLE CONTROL THEORY WITH AN APPLICATION TO THE CONTROL DESIGN OF AN INCORE THERMIONIC REACTOR. Ferg, D. A.; Brehm, R. L. (Univ. of Arizona, Tucson). pp 207-10 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A description is given of a control design technique which permits multiple input-output cross-coupling. The application to the control design of an ITR is briefly described as an example. (INIS)

42577 DYNAMIC BEHAVIOR OF THE ITR INSTALLATION UNDER VARIOUS OPERATING CONDITIONS AND DURING DISTURBANCES. Dagbjartsson, S. (Univ., Stuttgart); Siegel, K.; Klein, D.; Wettemann, G. pp 211-14 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Several temperature coefficients were calculated to recognize the mechanisms of heat transport. Heat flux and temperature curves were investigated for different disturbances (minor disturbances, scram, fracture of the primary loop). (INIS)

42578 WEIGHT OPTIMIZATION FOR RADIATION SHIELDINGS. Klumpp, W. (Univ., Stuttgart). pp 227-30 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The employment of nuclear reactors as energy sources in satellites requires an optimum design of the shading devices. For the calculation of the radiation field the solution of the transport equation by means of the S_n-method and dynamic programming are used with the computer program DOT2, DOSBE, and DYNOPT. Numerical examples are presented for layers of ^{238}U and LiH. (INIS)

42579 CALCULATION OF THE TEMPERATURE DISTRIBUTION AND THE UO_2 DISTRIBUTION IN THE EMITTER-FUEL SYSTEM OF THE ITR. Groll, M. (Univ., Stuttgart); Ehnis, L.; Krause, E. D.; Peehs, M. pp 786-8 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

For the design of the emitter-fuel system of the Incore Thermionic Reactor, detailed knowledge is required of the temperature and UO_2 distributions in order to avoid the swelling of the emitter-fuel system and to minimize the induced heat stresses. Therefore these quantities have been calculated numerically by solving the equation for stationary heat conduction. A maximum temperature of 2050°K is found. (INIS)

42580 IRRADIATION EXPERIMENTS WITH THERMIONIC CONVERTERS. Jester, A. (Brown Boveri und Cie AG, Mannheim, Ger.); Holick, H.; Krapf, R.; (and others). pp 789-92 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Results of irradiation experiments with a thermionic converter are described, where the fission gases could escape from the fuel cell to an ion-getter pump. The studies include the determination of power density distribution in the emitter (gamma scanning, burn-up), changes in the metal structure (micrographs, diffusion profiles), and the determination of fission gas release. Moreover, the formation of a layer of emitter material on the inner collector side has been observed. (INIS)

Process Heat and Desalination Reactors

42581 SITING A THERMAL MULTI-PURPOSE ENERGY CENTER. Scharpf, Carl A. (Bechtel France, Paris). Chem. Eng. Progr.; 68: No. 5, 26-9(May 1972).

The economic advantages of multipurpose power/chemical production plants are discussed. Costs are compared for alternate sites for both a single-reactor and a twin-reactor complex. (H.D.R.)

42582 SAFETY CONSIDERATIONS CONCERNING A NON-INTEGRATED PROCESS HEAT REACTOR. Barnert, Heiko (Kernforschungsanlage, Juelich, Ger.). pp 749-52 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Two failure types are described which do not occur in the AVR and THTR: rupture of coaxial coolant piping, and damages in the heat exchanger system (steam generator and chemical reactor). (INIS)

Research and Test Reactors

Refer also to abstracts 40991 and 41383.

42583 (INR-1347) THEORETICAL AND EXPERIMENTAL EVALUATION OF GAMMA HEAT GENERATION DISTRIBUTION IN EWA-10 REACTOR. Nycz, Czeslaw; Panta, Przemyslaw; Pytel, Krzysztof; Strupczewski, Andrzej (Institute of Nuclear Research, Warsaw (Poland)). 1971. 43p. Dep. NTIS (U. S. Sales Only).

The results of calculations and experimental measurements of gamma heat generation distribution in the core and reflector of EWA reactor are presented. In the calculations the influence of different burnup levels in various fuel zones has been taken into account. The results are given for several target materials interesting from the technical point of view. (17 references) (auth)

42584 (KFK-1064) FOEHN: THE CRITICAL EXPERIMENT FOR THE GERMAN-FRENCH HIGH FLUX REACTOR. Scharmer, Klaus; Eckert, Hans G. (Kernforschungszentrum, Karlsruhe (West Germany)). Dec 1971. 185p. (In German). Dep. NTIS (U. S. Sales Only).

A critical experiment for the Franco-German high flux reactor was made in the French reactor EOLE (CEN-Cadarache). The experiment was carried out with the objective to test calculational methods in realistic geometry and to measure effects which cannot be readily determined by theoretical means (e.g., beam tube effects). The experimental mockup and theoretical and experimental methods are described. A detailed comparison of theoretical and experimental results was made. (30 references) (auth)

42585 (RT/ING-(72)4) FINAL SAFETY REPORT OF THE RB-3 REACTOR, JANUARY 1972. Casali, F.; Manzini, R.; Orru, G.; Vanossi, A.; Zappellini, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 9 Feb 1972. 201p. (In Italian). Dep. NTIS (U. S. Sales Only).

The nuclear plant is described and some hypothetical nuclear accidents are analyzed. (14 references) (auth)

42586 COMPTON SCATTERED NEUTRON CAPTURE GAMMA RAYS FOR PHOTOFISSION STUDIES. Anderl, R. A.; Hall, J. E.; Morrison, R. C.; (and others) (Ames Lab., Iowa). Nucl. Instrum. Methods; 102: No. 1, 101-8(1972).

A novel facility for producing photons of continuously variable energy from 3.0 MeV to 8.0 MeV has been constructed at the Ames Laboratory Research Reactor. Gamma rays produced by neutron capture in the reactor are Compton scattered from a curved aluminum plate whose curvature is easily varied for different scattering configurations. This facility has been used for photofission yield measurements and preliminary results of the relative photofission cross section from 5.0 MeV to 8.0 MeV are presented for ^{238}U. (auth)

42587 METHOD FOR OBTAINING A HOMOGENEOUS FLUX IN A REACTOR BEAM TUBE. Kedem, D.; Mahlav, M.; Pelah, I. (Soreq Nuclear Research Centre, Yavne, Israel). Nucl. Instrum. Methods; 102: No. 1, 87-92(1972).

For some types of neutron beam experiments it is necessary to have a homogeneous high neutron flux over a large area. Such a beam was obtained using a plain tube collimator and a shaped absorber, specially designed and built for this purpose. (auth)

42588 STUDIES FOR BULK SHIELD OPTIMIZATION FOR APSARA REACTOR. COMPUTER CODE SHIELD AND APPLICATIONS TO OTHER STUDIES. Sankaranarayanan, S.; Narain, Rajendra; Sen Gupta, S. N. (Bhabha Atomic Research Centre, Trombay, India). pp 119-31 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

The available neutron fluxes for experiments in Apsara Reactor beam holes could be augmented by significant reductions in the bulk shield. The study presents the analysis of attenuation of neutrons and gamma rays through the bulk shield with a relatively simple model for the calculations. Commonly used shield materials have been considered for the attenuation of the primary radiations from the core and secondary radiations originating in the shield. The FORTRAN computer program SHIELD, commissioned for estimating the fast neutrons, thermal neutrons, primary and secondary gamma rays was used in order to evaluate the large number of combinations for bulk shields. It has been observed that the bulk shield could be reduced to about 1.6 m by using pool water, iron (mild steel) and lead with a consequent 5 fold increase in available neutron fluxes from the beam holes. Usefulness of the computer code SHIELD to other studies is illustrated by its application to a typical operational problem in fast neutron irradiation facilities. (auth)

42589 FEASIBILITY STUDY ON ASSEMBLING INDEPENDENTLY CRITICAL SUB-CORES IN A LARGE ZERO ENERGY EXPERIMENTAL HEAVY WATER REACTOR. Srinivasan, M. (Bhabha Atomic Research Centre, Trombay, India). pp 179-90 of Proceedings of the National Symposium on Radiation Physics. Bombay; Bhabha Atomic Research Centre (1971).

From National symposium on radiation physics; Bombay, India (24 Nov 1970). See CONF-701138.

As the size of natural uranium fuelled heavy water moderated power reactors becomes larger, on account of neutronic decoupling between the various regions, xenon oscillation and other stability and control problems become important. To study the kinetics of loosely coupled lattice reactors, two or more neutronically decoupled sub-cores may be assembled in a zero energy experimental lattice reactor. The feasibility of obtaining independently critical sub-cores in a large zero energy reactor was investigated using a source-sink type heterogeneous theory code. It was found that with separations of over 120 cms between the sub-cores the interaction between them becomes negligible. With about 100 typical natural uranium metal rods (~32 mm dia) and critical moderator levels below 200 cm in a 335 cm dia graphite reflected tank reactor, very interesting and useful coupled reactor experiments could be carried out. (auth)

42590 INVERSE KINETIC REACTIVITY MEASUREMENTS CONCERNING FRJ-1, FRJ-2, AND AVR (JUELICH) DR-3 (RISOE) AND FRG-0 (GEESTHACHT). Kalker, K. J. (Kernforschungsanlage, Juelich, Ger.). pp 62-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A description is given of the problems concerning the absorber calibration and the reactivity measurement in dependence of the reactor situation. The special features of the measurements of the reactivity curve of the various reactors are explained. (INIS)

42591 PHYSICAL INVESTIGATION OF SODIUM-COOLED FAST CORES ARRANGED IN SMALL PLATE AND ROD CON-

FIGURATION. Helm, F.; Jourdan, G.; Plum, F. (Kernforschungszentrum, Karlsruhe, Ger.). pp 98-101 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A description is given of the configuration of SNEAK-6 and its three different variants suitable for axial and central measurements. The effective multiplication factor was calculated, the axial power distribution was determined by calculation and experiment, and the sodium-void effect was measured. The experimental determination of the reactivity modification is supplemented by control rod experiments. (INIS)

42592 ADVANCES IN THE IMPROVEMENT OF GROUP CONSTANTS AS COMPARED WITH THE RESULTS OF INTEGRAL EXPERIMENTS. Kiefhaber, E. (Kernforschungszentrum, Karlsruhe, Ger.). pp.122-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Improvements in the group constants, as compared to the set MOXTOT, are presented. They are concerned with the most important fuel isotopes ^{235}U, ^{238}U, ^{239}Pu and with small changes in ^{240}Pu. With these new values, the criticality of all assemblies that have been investigated could be predicted up to 1%. (INIS)

42593 MEASUREMENTS IN A CRITICAL ASSEMBLY OF FUEL ELEMENTS FOR POWER REACTORS. Mayer, W.; Andres, R. (AEG-Kernenergieversuchsanlage, Grosswelzheim, Ger.). pp 182-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A description is given of the critical assembly in the AEG nuclear power test facility Grosswelzheim and of its employment for the testing of finished fuel elements for power reactors. The experimental and test program is described and the results of some representative examples for typical measurements are given. (INIS)

42594 OPERATING EXPERIENCE CONCERNING THE FAST-ZERO-ENERGY-FACILITY KARLSRUHE (SNEAK). Bickel, W.; Wittek, G. (Kernforschungszentrum, Karlsruhe, Ger.). pp 474-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Following the description of various surveying and control devices, the Pu-contamination in summer 1969, its removal, and probable reasons (comparative tests) are reported. (INIS)

42595 ADVANCES IN FUEL ELEMENT DESIGN FOR MTR REACTORS. Koch, K.-H.; Lange, E.; Mueller, N. (Nuklear-Chemie und -Metallurgie GmbH, Wolfgang, Ger.). pp 714-17 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The wish to increase the neutron flux density of existing or planned MTR reactors has led to the use of new uranium compounds such as UAl_3, which makes for an increase in uranium content in the fuel zones by 30%. Another means of increasing the neutron flux density is to change the fuel geometry, i.e., to choose tubular fuel elements, or else to use a ring core. These newly designed MTR fuel elements still include turnable neutron poisons which requires new methods to be applied in fuel fabrication. A number of feasible production steps for the fabrication of MTR elements are illustrated, followed by a discussion of problems involved in this process. (INIS)

42596 FUEL ELEMENT HANDLING IN THE RESEARCH REACTOR FR3. Grundmann, M. (AEG-Telefunken, Grosswelzheim, Ger.). pp 741-4 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The fuel element charging and discharging inside the reactor containment, the fuel element transport inside the reactor building, and the fuel element cooling are described. The results of a time schedule study for the handling are presented. (INIS)

42597 IRRADIATION INSTALLATIONS OF THE ESSOR REACTOR. Riesch, Gerhard (EURATOM, Ispra, Italy). pp 758-61 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Main data of the heavy-water-moderated ESSOR reactor and of the planned light water coolant loops for the irradiation of power reactor fuel elements are presented. (INIS)

42598 REACTOR PLUG-IN UNITS FOR HIGH TEMPERATURE FUEL IRRADIATIONS. DESIGN AND OPERATIONAL EXPERIENCE. Krug, W. (Kernforschungsanlage, Karlsruhe, Ger.); Lehrheuer, W.; Schmidt, F.; (and others). pp 762-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A description is given of the construction and function of the irradiation rigs (including scavenging loops and instrumentation) as are used for the reactors FRJ-2, BR-2, and R-2. The encountered difficulties (leaks etc.) are mentioned. (INIS)

42599 SWEEP CIRCUIT SYSTEMS FOR THE HTR IRRADIATION EXPERIMENTS: DESIGN AND FISSION GAS MEASUREMENTS. Stechemesser, H. (Kernforschungsanlage, Karlsruhe, Ger.); Bachner, E.; Bertram, W.; (and others). pp 766-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The closed sweep circuits for the transport of fission products in the irradiation capsules in the FRJ-2 are described. The manual gas sampling with subsequent lab measurement for the fission gas measurement in the by-pass circuit has been developed to automatic fission gas spectrometry with program-controlled sampling for multiple systems. (INIS)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 40765, 40783, 40789, 41319, 41321, 41324, 41328, 41337, 41338, 41346, 41354–41358, 41370, 41379–41382, 41391, 41392, 41399, 41401–41415, 41447–41449, 41468, and 41470.

42600 TEMPERATURE MEASUREMENTS IN REACTORS BY MEANS OF NOISE THERMOMETRY. Brixy, H. G. (Kernforschungsanlage, Juelich, Ger.). pp 82-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The Nyquist formula is used for determining the temperature. The noise voltages of two resistors are compared, the one at the unknown temperature, the other at room temperature. The ratio of the resistances, when the noise voltages from the two resistors are equal, determines the ratio of their absolute temperatures. Several temperatures are measured in the range from 300 to 1100°K with an accuracy better than 0.2 percent. The noise thermometer is independent of the material from which it is made or its previous thermal and mechanical treatment. It is also independent of the nuclear radiation environment and therefore especially suitable for temperature measurement in nuclear reactors. (INIS)

42601 IMPACT OF RANGE SPACERS ON THE CRITICAL HEAT TRANSFERRED PER UNIT SURFACE. Hein, D.; Koehler, W.; Mayinger, F. (Maschinenfabrik Augsburg-Nuernberg AG, Nuremburg). pp 162-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A description is given of the two main types of range spacers which are used for light- and heavy-water reactors: furnished with knubs in the spacers or suitable for the integration of fuel cans with fins. Investigations under reactor operation conditions demonstrate the impact of the mass flow on the region of burnout. A 10–20% higher critical heat transferred per unit surface resulted from the application of range spacers furnished with rifling lugs for the activation of turbulence. (INIS)

42602 BURN-UP DETERMINATION BY IRREVERSIBLE ADDITION OF ACTIVABLE NUCLIDES TO THE NUCLEAR FUEL. Muench, E. (Kernforschungsanlage, Juelich, Ger.). pp 194-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A method is described which permits burnup determination after addition of an activable nuclide from the γ-line in the fission product spectrum by integration of the neutron flux density.

The usefulness of this technique is demonstrated by using ^{58}Co as an example. (INIS)

42603 NUMERICAL TREATMENT OF STATIONARY HEAT CONDUCTION IN PIECEWISE HOMOGENEOUS MEDIA. Walther, Heinrich (Kernforschungsanlage, Juelich, Ger.). pp 304-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A mathematical investigation is performed of the heat conduction in bulks of small spherical particles. This problem arises in nuclear reactors with coated particles as fuel elements. If the bulk of particles is described by a mean heat conduction coefficient, one has to relate this coefficient to the real heat conduction parameters of the constituent materials. This is done in numerical way for several regular configurations of the spheres. (INIS)

42604 CALCULATION OF THERMOELASTIC STRAINS CAUSED BY PRESUMED RADIAL AND AZIMUTHAL TEMPERATURE VARIATIONS IN FUEL CANS. Krieg, R. (Kernforschungszentrum, Karlsruhe, Ger.). pp 308-11 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The calculation of internal strains caused by nonaxially symmetrical temperature gradients is explained. The thermal stress problem is reduced to a normal stress and strain problem. The appropriate constants are determined by means of the heat sources and the temperature distribution. The theorem on thermal stresses regarding the two-dimensional strain situation is derived. (INIS)

42605 EXPERIENCE WITH REACTOR ARMATURES IN H_2O-PRESSURIZED WATER REACTORS. Bruhn, H. (Siemens AG, Erlangen, Ger.). pp 359-61 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Procedures and experience are reported concerning the selection of suitable valves from the program offered by the industry and its adaption to reactor requirements. Moreover, a valve test stand under construction is mentioned. (INIS)

42606 MONITORING OF IMPURITY CONCENTRATIONS IN LIQUID SODIUM. Schwarz, N.; Staufer, A. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria). pp 387-90 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A plugging meter is described which is operated in a balanced state between dissolution and plugging. Quasi-continuous measurements are made for the determination of the efficiency of a cooling trap in the Na loop. (INIS)

42607 COMPARISON OF TEST RESULTS OF PROCEDURE TESTING AND OF MANUFACTURING TESTING OF WELDED PLATINGS AND JOINT WELDINGS ON COMPOUND MATERIALS IN NUCLEAR REACTOR CONSTRUCTION. Grossmaas, H.; Mueck, G. H. (Rheinisch-Westfaelischer Technischer Ueberwachungs-Verein eV, Essen). pp 399-402 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Such problems are discussed as arise in connection with testing methods and thus with the achievement of reliable results on the operational applicability and safety of a certain project. (INIS)

42608 DEVELOPMENT OF INTERMEDIATE GRID ASSEMBLIES FOR FUEL ELEMENTS AT REACTOR CENTRUM NEDERLAND. Piepers, G. G. (Reactor Centrum Nederland, Petten). pp 436-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The result of the development is a spring clip providing a constant hold-down force within a certain range of deformation by way of a special shape. The requirements for keeping the fuel rods in position even in the case of relatively large outer forces (e.g., in fuel elements of ship reactors) and low neutron absorption are satisfied by a construction consisting of a Zircaloy frame and Inconel supporting points. Both materials are connected by a spotwelding technique. The welding parameters are given. (INIS)

42609 DETECTION OF FAILED FUEL SUBASSEMBLIES BY THE SIPPING TECHNIQUE. De Donder, M.; Prevot, J. (Societe Belge pour l'Industrie Nucleaire, Brussels). pp 453-6 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The main idea of the "sipping" method is to isolate every assembly in a confined volume of water or gas and to analyze samples after an eventual temperature rise. Any abnormal increase in the fission product concentration is a sure sign of a cladding failure. The experience of BELGONUCLEAIRE is given, gained by two reloadings of the BR-3, and by tests on fuel elements for the SNR. (INIS)

42610 IN-CORE STUDY OF THE INFLUENCE OF IMPORTANT FUEL DESIGN PARAMETERS ON THE ELONGATION AND BAMBOO-RIDGE FORMATION OF ZIRCALOY-2 CLAD UO_2 FUEL RODS. Rolstad, E.; Knudsen, K. D. (Institutt for Atomenergi, Halden, Norway). pp 539-42 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A series of experiments is described where the influence of the pellet length, pellet end-shape, clad thickness, and fuel-to-clad clearance upon the fuel pin elongation and "bamboo-ridge" formations were systematically studied. (INIS)

42611 EXPERIMENTAL INVESTIGATIONS OF THE INTERACTIONS BETWEEN $(U,Pu)O_{2-x}$ AND FUEL CAN OF AUSTENITIC STEEL. Coquerelle, M. (EURATOM, Karlsruhe, Ger.); Andriessen, H.; Hoppe, N. pp 570-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Two fuel rods with sintered or vibrated mixed oxides have been irradiated in the epithermal flux of the BR-2 and investigated with the aim of comparing the behavior of the differently prepared fuel in the fuel rods. The various modes of damage observed in the fuel can, consisting of V_2A steel DIN 1-4961, and the interactions between can and fuel are illustrated. (INIS)

42612 IMPROVEMENT OF THE RETENTION ABILITY OF COATED FUEL PARTICLES FOR SOLID FISSION PRODUCTS BY ADDITIONS OF SELECTED METAL OXIDES TO THE FUEL KERNEL. Nickel, H.; Foerthmann, R.; Hamesch, M. (Kernforschungsanlage, Juelich, Ger.). pp 634-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The idea underlying the investigations was to improve the retention ability of oxide fuel material by adding small quantities of certain oxides which will form stable compounds with the solid fission products (e.g., spinels) and thus retain them in the fuel kernel. ZrO_2, Nb_2O_5 and Al_2O_3 additions were considered useful and have been tested in out-of-pile experiments. The results of the first series of experiments with Al_2O_3 additions include production of model fuel kernels, annealing of uncoated as well as of pyrocarbon-coated particles at various temperatures, and gamma spectrometric determination of fission gas release. (INIS)

42613 DETERMINATION OF CONCENTRATION PROFILES AND SOLID FISSION PRODUCT RELEASE ON IRRADIATED HTR FUEL PARTICLES. Engelhard, J.; Mioduszewski, P. (Kernforschungsanlage, Juelich, Ger.). pp 638-41 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A series of experiments are described that have been made for the purpose of systematically investigating the fission product transport mechanisms in the coated fuel particles and in the graphite matrix of fuel elements. For a number of solid fission products it was possible to establish sufficiently accurate values for release rates. The mathematical verification of the measured results which was made to obtain appropriate diffusion and evaporation coefficients is based on Fick's law. (INIS)

42614 RELEASE OF IODINE FROM FUEL ELEMENTS OF A HIGH-TEMPERATURE REACTOR. Schmidt, A. (Brown Boveri/Krupp Reaktorbau GmbH, Cologne). pp 646-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The I-activity in the coolant gas occurs by release of I and Te isotopes from coated fuel particles i.e., I-transport through graphite. Differences in the experimental results are evaluated under the assumption that I migrates along the pores and that the migration velocity is determined by the adsorption-desorption equilibrium in the pores. The ^{131}I release is essentially below that of ^{133}Xe. (INIS)

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42615 NON-DESTRUCTIVE METHOD OF MEASURING INITIAL FISSION CAPTURE RATIOS IN UO_2 FUEL ELEMENTS. Yurova, L. N.; Bushuev, A. V.; Kozhin, A. F.; Chachin, V. V. At. Energ. (USSR); 32: No. 5, 412-15(May 1972). (In Russian).

It is possible to separate γ lines which belong to products of the reaction $^{238}U(n,\gamma)$ if a system with high resolution, such as a Ge(Li) spectrometer, is used. The gamma spectra of fuel elements were measured at various degrees of uranium enrichment. Experiments were conducted on compensation of self-absorption in fuel elements. The distribution of the reactions $^{238}U(n,\gamma)$ and $^{235}U(n,f)$ was determined in fuel elements of a critical $U-H_2O$ assembly. (3 figures) (K.S.W.)

42616 GENERAL SOLUTION OF REACTOR KINETIC EQUATIONS FOR ONE GROUP OF DELAYED NEUTRONS AND TIME DEPENDENT REACTIVITIES. Sandquist, G. M. (Univ. of Utah, Salt Lake City). J. Nucl. Energy; 26: No. 5, 213-30 (May 1972).

A new method of obtaining analytic solutions of the space independent reactor kinetic equations for arbitrary time dependent reactivities is presented. The method is based upon transforming the kinetic equations with one group of delayed neutrons into a single Ricatti equation for the system. This single equation permits a variety of useful approximate solutions which are generally considerably more accurate than approximate solutions obtained for the standard kinetic equations. General perturbation solutions of the single equation for the system are found and are shown to be valid even for very large changes of the dependent variables. Specific solutions for step, impulse, ramp sinusoidal and generalized reactivities are found. The solution for sinusoidal reactivities confirms that unstable exponential flux growth occurs due to the presence of delayed neutrons, while without delayed neutrons the solution is oscillatory but bounded. Finally the exact solution is found for the system when the reactivity is an analytic function. (auth)

42617 CHANGE IN REACTIVITY DURING SHUTDOWNS OF A HIGH-FLUX REACTOR. Zaritskaya, T. S. This paper was summarized in At. Energ. (USSR); 30: No. 1, 46(Jan 1971) as paper No. 456/5481. (In Russian).

The change in reactivity during shutdown of a high-flux reactor due to ^{135}I, ^{135}Xe, ^{149}Pm, and ^{149}Sm is calculated. The dependence of this process on the steady-state operating power before shutdown is studied. The general nature of the reactivity change is as follows: there is first a rapid buildup of ^{135}Xe from the decay of ^{135}I, then the decay of ^{135}Xe, and finally the slow buildup of stable ^{149}Sm due to the decay of ^{149}Pm. It is established that for a neutron flux of $2.6 \cdot 10^{14}$ neutrons/cm$^2 \cdot$ sec the asymptotic value of the reactivity for infinitely long shutdown is the same as the steady-state reactivity before reactor shutdown, and for a flux of $3.2 \cdot 10^{14}$ neutrons/cm$^2 \cdot$ sec the steady-state value of the reactivity agrees with the minimum in the shutdown process when ^{135}Xe has decayed and ^{149}Sm has not yet been formed. The results of the calculations serve as reference material in choosing shutdown procedures for high-flux reactors. (auth)

42618 SOLUTION BOUNDS FOR NONLINEAR SPACE–TIME REACTOR PROBLEMS. Reister, David B. (State Univ. of New York, Buffalo); Chambre, Paul L. Nucl. Sci. Eng.; 48: No. 2, 211-18(Jun 1972).

Current approximation methods for space-time reactor problems with temperature feedback lack an error estimate. The method discussed yields an approximate solution with an error estimate. Upper and lower bounds are sought for the flux and temperature at all points in a reactor for all time. The bounds are the solutions of a set of ordinary differential equations which are similar to the point model equations. Having chosen an unusual nonlinear form for the bounds, a comparison theorem of the Nagumo–Westphal type is used to derive the equation which the bound must satisfy. Optimum control theory and Pontryagin's Maximum Principle determine the optimum bounds. In an example, bounds are determined for three standard nonlinear reactor models. The bounds are narrow and lead to interesting conjectures about the exact solution. (15 references) (auth)

42619 CRITICALITY AND GRAPH THEORY. Merkwitz, J. (Kernforschungszentrum, Karlsruhe, Ger.). pp 3-6 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The criticality problem of a nuclear reactor is treated within the framework of graph theory. Conditions are given for which the problem has a unique solution and for which this solution is stable. (INIS)

42620 EXISTENCE OF NON-NEGATIVE SOLUTIONS FOR A GENERAL STATIONARY NEUTRON TRANSPORT EQUATION. Ebersoldt, F. (Kernforschungsanlage, Juelich, Ger.). pp 7-10 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Using function-analytical methods, especially from the theory of semigroups and compact operators, some statements on transport theory that are important for reactor physics are derived in a mathematically exact way. At the same time, they justify some often used approximation methods. (INIS)

42621 SPACE-ANGLE-ENERGY SYNTHESIS METHOD. Schwetje, W. (Kernforschungszentrum, Karlsruhe, Ger.). pp 11-14 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Fast flux synthesis methods which have been used in diffusion theory are proposed for the solution of the transport equation. In order to estimate the applicability and the usefulness of such methods, four different procedures are given and applied to the solution of the multigroup neutron transport equation for plane geometry and isotropic scattering in several inhomogeneous problems (plates with a neutron flux impinging from one side). The results agree very well with those of analogous S16 calculation, the computing time, however, is much shorter for the synthesis method. (INIS)

42622 SOLUTION OF THE INTEGRAL BOLTZMANN EQUATION FOR SPACE-DEPENDENT FAST NEUTRON SPECTRA. Gerwin, H.; Wolf, L. (Kernforschungsanlage, Juelich, Ger.). pp 15-18 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Three methods are described for the calculation of the transport kernel of the integral Boltzmann equation in the fast energy region: piecewise integration in general geometry by a Monte Carlo method and analytical calculations of the transport kernel, either not energy-dependent or energy-dependent, for spherical symmetrical configurations in spherical geometry. (INIS)

42623 SOLUTION OF THE STATIONARY NEUTRON TRANSPORT EQUATION IN SPHERICAL SYMMETRY. Hanke, W. (Kernforschungsanlage, Juelich, Ger.). pp 19-21 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The general stationary neutron transport equation with a source term is solved for spherical symmetry by means of a S(N)-method. A FORTRAN program with variable dimensions is available for this method. Test calculations with GODIVA data are in good agreement with measured values. (INIS)

42624 NUMERICAL METHOD FOR THE SOLUTION OF THE ONE-DIMENSIONAL TRANSPORT EQUATION. Lindenmayr, G. (Kernforschungsanlage, Juelich, Ger.). pp 22-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A system of difference equations for the solution of the neutron transport equation is described that has much better convergence properties than the usual S(N) methods. The one-dimensional transport equation in spherical geometry is transformed into a Volterra integral equation and further, after discretization of the variables, into a system of difference equations. This system is solved by means of three different iterative methods. (INIS)

42625 FAST METHOD FOR THE CALCULATION OF THREE-DIMENSIONAL FLUX DISTRIBUTIONS BY MEANS OF COLLISION PROBABILITIES. Mueller, A.; Bennewitz, F. (Siemens AG, Erlangen, Ger.). pp 26-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The proposed box method is derived from the integral Boltzmann equation and can be applied to an arbitrary number of energy groups. Two-dimensional 2-group calculations show a high accuracy of the method for short computing times. (INIS)

42626 MULTIGROUP NEUTRON TRANSPORT BURNUP PROGRAM NEUTRA AND ITS APPLICATION. Krueger, A.; Mueller, A. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). pp 30-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

NEUTRA is a FORTRAN program in modular form and overlay technique. It solves the multigroup neutron transport equation by means of the S(N) method and calculates the burnup of nuclides using quasianalytical solutions of the burnup equations and assuming piecewise time constant neutron flux. The program was developed especially for the burnup of burnable poisons, for burnup, flux, power and reactivity studies in fuel lattices with burnable poisons, and for burnup, flux and power studies near strongly inhomogeneous locations. NEUTRA was used for the theoretical investigation of the burnup experiments at Geesthacht. An experiment of this series is described as an illustrative example. (INIS)

42627 DATA FORMAT AND CONTROL OF THE REACTOR PROGRAM SYSTEM RSYST. Ruehle, R. (Univ., Stuttgart). pp 38-41 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The system, data format, data storage and control of RSYST are reported. The modulus groups realized in RSYST are described briefly. Moreover, the problems with regard to a transformation on IBM 360/75 are outlined. (INIS)

42628 MEASUREMENT OF FISSION AND CAPTURE RATES BY MEANS OF FISSION TRACK DETECTORS AND Ge(Li) DETECTORS. Korthaus, E.; Goel, B.; Guenther, G.; Scholtyssek, W. (Kernforschungszentrum, Karlsruhe, Ger.). pp 50-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The work consists of two parts: (1) ^{238}U capture rate measurement with Ge(Li) detectors in the SNEAK-7A. The method is based on the determination of the ^{239}Np activity in irradiated U foils. (2) Automatic counting of fission track detectors. The track counter "Classimat" (Leitz) and the computer evaluation (FORTRAN IV) are described. (INIS)

42629 DETERMINATION OF FAST REACTOR SPECTRA BY MEANS OF MEASUREMENTS WITH BORON FILTERS. Hofmeester, G. H. (Reactor Centrum Nederland, Petten). pp 54-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The STEK assembly is used to perform integral measurements of fission product cross sections for which an accurate knowledge of the neutron spectrum is required. This is determined by means of B filter transmission experiments. A collimated neutron beam passes through ^{10}B filters of variable thickness. The counting rate of a ^{6}Li neutron detector (NE 912) behind the filters is measured as a function of the filter thickness. The principle of the method is that for increasing filter thickness the neutron attenuation occurs at different rate for different energies. (INIS)

42630 MEASUREMENT AND CALCULATION OF FAST NEUTRON SPECTRA OF REACTORS FOR THE TESTING OF GROUP SETS. Werle, H.; Wattecamps, E.; Bluhm, H.; (and others) (Kernforschungszentrum, Karlsruhe, Ger.). pp 58-61 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971) (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Investigations were made on error possibilities of measurements of neutron spectra and on discrepancies between calculated and measured spectra. Improvements and extensions of the measuring procedures are specified for: ^{3}He–semiconductor sandwich spectrometers, proton recoil proportional counters, time-of-flight method and sandwich technique. Also reported are comparisons of measurements concerning SNEAK- and SUAK-cores. Using the example of SNEAK measurements it is shown that the presently attained accuracy of measurements is quite sufficient to detect failures in the calculated spectra. (INIS)

42631 THEORETICAL INVESTIGATIONS ON SPACE-DEPENDENT REACTOR NOISE ANALYSIS USING GAMMA RADIATION. Kostic, Lj.; Seifritz, W. (Technische Univ., Hanover). pp 66-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The theory of space-dependent stochastic fluctuations of prompt γ-rays in an infinite multiplying medium is developed in the frequency region. The investigations are based on the 1- and 2-group energy diffusion equations. The approach used is Langevin technique which yields: (1) the spectral density functions as a double convolution over the Green's functions and (2) the spectral density function of equivalent "noise sources" within the system. (INIS)

42632 INVESTIGATION OF THE KINETICS OF COUPLED REACTOR REGIONS BY MEANS OF AN ANALYSIS OF THE REACTOR NOISE. Ehrhardt, J.; Edelmann, M. (Kernforschungszentrum, Karlsruhe, Ger.). pp 74-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A description is given of the determination of the correlation functions of a symmetrical two-point model by the analysis of counter tube signals obtained from Rossi-α- and variance and from covariance measurements. These theoretical results have been confirmed by experiments in the two-region assembly of the thermal Argonaut Reactor Karlsruhe. (INIS)

42633 EFFECTIVENESS OF TRIMMING SHUT-DOWN RODS IN A LOOSELY COUPLED TWO-REGION CONFIGURATION. Roethemeyer, H. (Physikalisch-Technische Bundesanstalt, Brunswick). pp 78-81 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A comparison is given of the results of an investigation of a two-point model with the results of experiments concerning the effectiveness of reactivity breaks. The results are in good agreement. (INIS)

42634 GROUP CONSTANTS FOR CONSISTENT P1-CALCULATIONS WITH 208 ENERGY GROUPS. Braun, J.; Hinkelmann, B.; Huschke, H.; (and others) (Kernforschungszentrum, Karlsruhe, Ger.). pp 110-13 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Some problems require a refinement of the usual 26-group calculations for fast reactors. These include direct comparison of measured and calculated neutron spectra and the problems of macroscopic and microscopic weighting. Therefore, a data file and a set of computer programs has been developed, allowing to calculate macroscopic group cross sections for arbitrary mixtures in a 208-energy groups picture. Furthermore, a zero-dimensional and a one-dimensional consistent P1 code has been developed. (INIS)

42635 SOME HIGHLIGHTS OF THE THREE YEAR BELGIAN CRITICAL EXPERIMENT AND CODE CALIBRATION WORK ON UO_2–PuO_2–H_2O LATTICES. Bindler, L. (Societe Belge Nucleaire pour l'Industrie Nucleaire, Brussels); Charlier, A.; Debrue, J.; Leenders, L.; Van den Broeck, H. pp 178-81 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A comment is given on the basic critical experiment program. Moreover such problems are investigated by experiment and calculation as arise from the application of plutonium fuel. The most important problems which are investigated are the power distribution (for example: plutonium fuel assembly in Dodewaard) and the effects on the reactivity in the case of boron poisoning of the water moderator. (INIS)

42636 TWO-DIMENSIONAL REACTOR DYNAMICS BY THE QUASISTATIC METHOD. Mayer, L.; Bachmann, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 215-18 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The computer code KINTIC, developed at Karlsruhe, that treats the space-dependent dynamics for fast reactors in the quasistatic approximation is described. A comparison with the fully numerical code MITKIN shows the advantages of the quasistatic method. (INIS)

42637 TWO DIMENSION CODE COSTANZA (R,Z) FOR THE STUDY OF DYNAMIC TRANSIENTS, XENON OPERATIONAL TRANSIENTS, AND XENON STABILITY. Vincenti, E. (EURATOM, Ispra, Italy). pp 235-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A description is given of two codes, one being used for the calculation of dynamic transients and the other for the calculation of xenon operating transients and xenon stability investigations. (INIS)

42638 TREATMENT OF SPACE DEPENDENCE OF THE ENERGETIC RESONANCE SELF-SHIELDING AT THE INTERFACES OF HOMOGENEOUS ZONES. Huschke, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 273-6 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The treatment of the energetic resonance self-shielding in multigroup calculations by means of the f-factor formalism is quite inaccurate near zone boundaries. Therefore, in order to determine the resonance structure of the neutron flux density near an interface, the integral neutron transport equation with isotropic scattering is solved for the model of two half spaces with different resonance structure. The space dependence of the energetic resonance self-shielding is found to be appreciable only within two mean free paths at both sides of the interface. For small reflected systems, this space dependence leads in general to an increase of criticality. (INIS)

42639 EFFECT OF DOPPLER BROADENING ON INTERMEDIATE RESONANCE INTEGRALS. Faber, C.; Henssen, H.; Huebner, H. (INTERATOM, Bensberg, Ger.). pp 277-80 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The introduction of the intermediate resonance (IR) method brought about a substantial progress in the analytical solution of the transport equation in the resonance region. An analysis is made of the errors occurring in the calculation of the resonance integrals if Doppler broadening is taken into account for the cross sections, with the IR parameters for $T = 0$ being used. For this purpose, the resonance integrals are calculated for three different temperatures, with IR parameters either for $T = 0$ or for the given temperatures, and are compared with exact numerical values. It is found that the resonance integrals can be calculated from IR parameters at $T = 0$ as long as the resonances show a strong absorption or if the cross section of the NR moderator for potential scattering is large. (INIS)

42640 MORSE-K, A MONTE CARLO PROGRAM FOR THE RAPID AND RELIABLE CALCULATION OF THREE DIMENSIONAL REACTOR AND SHIELDING CONSTRUCTIONS. Schmidt, F. A. R.; Bernnat, W.; Singh, K. (Univ., Stuttgart). pp 281-4 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A description is given of the development of the Monte Carlo program MORSE and its capabilities are demonstrated by means of two examples: calculation of shielding properties and multiplication factors. (INIS)

42641 MONTE CARLO PERTURBATION CALCULATIONS IN MULTIPLICATING MEDIA. Rief, H.; Matthes, W. (CCR-EURATOM, Ispra, Italy). pp 285-8 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The determination of small effects by comparing two independent Monte Carlo calculations is impossible if the difference between the two results is of the same order of magnitude or smaller than their statistical fluctuations. Because of the great importance of such differential effects in reactor analysis, two methods have been developed at Ispra, allowing their calculation by means of the Monte Carlo technique. As for the first method, a stationary neutron distribution is produced from a source iteration and the differential effects are calculated by the method of similar flight paths. The second method makes use of the adjunct fission density distribution. (INIS)

42642 CELL CALCULATION CONCERNING DOUBLE HETEROGENEITY AND ITS APPLICATION TO A NEW PEBBLE-BED REACTOR DESIGN. Teuchert, E.; Hansen, U.; Maly, V. (Kernforschungsanlage, Juelich, Ger.). pp 289-91 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

It is shown that the consideration of the grain distribution in the matrix (filled with coated particles) is very important in the case of an occurrence of plutonium. The computing model and its conditions are described as well as the results from the application of the OTTO-concept (Once Through Then Out). (INIS)

42643 THERMALIZATION IN A LATTICE IN THE CADILHAC MODEL USING LINEAR ANISOTROPIC INTEGRAL TRANSPORT KERNELS. Royl, P. (Univ., Stuttgart. Technische Univ., Berlin). pp 296-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A quick method was developed for the calculation of thermal neutron spectra in strongly heterogeneous Wigner–Seitz cells. The neutron transport in the cylinderized cells is described by the integral transport equation. The usual first-flight methods are extended by inclusion of linearly anisotropic sources. The exact scattering kernels of the different scattering media for which linearly anisotropic scattering is allowed are approximated by the synthetic kernels of the Cadilhac model. (INIS)

42644 COMPUTATION OF THE ENERGY RELEASE BY FISSION PRODUCTS WITH A STATISTICAL ERROR STUDY. Lahner, K.; Vossebrecker, H. (INTERATOM, Bensberg, Ger.). pp 300-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Considerations are presented concerning the accuracy of the INTERATOM data bank of 276 isotopes with data on direct yield values of the ^{235}U and ^{239}Pu fission, on the average β- and γ-energy, on the half-lives, and on the γ-spectrum within 12 energy ranges. Calculation of the energy of β- and γ-decays in reactors with the RASPA code is described. (INIS)

Core Thermal Hydraulics

42645 CALCULATION OF THE PROCESSES OF UNSTEADY HEAT TRANSFER IN REACTORS COOLED WITH A SINGLE-PHASE INCOMPRESSIBLE COOLANT WITH ALLOWANCE FOR DISTRIBUTED PARAMETERS. Bukrinskii, A. M.; Pevzner, V. I. Therm. Eng. (USSR) (Engl. Transl.); 18: No. 4, 46-50(1971).

Translated from Teploenergetika; 18: No. 4, 31-4(1971).

A method is described for calculating the processes of transient heat transfer in reactor coolant channels. The method accounts for the distribution of parameters over the channel length. The coolant is assumed to be a single phase incompressible fluid in which no boiling occurs. (H.D.R.)

42646 THERMAL DESIGN ASPECTS OF FUEL ROD BUNDLES WITH EMPHASIS ON INTERSUBCHANNEL MIXING. Nijsing, R.; Eifler, W. (EURATOM, Ispra, Italy). pp 126-9 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A summary description of a computation method for the steady-state thermo-hydraulic analysis of fuel rod assemblies cooled by a fluid in single phase flow is presented. The "lumped parameter" approach used involves the subdivision of the bundle flow area into a number of parallel subchannels. Hydrodynamic and thermal conditions of the coolant in each of these are characterized by bulk average values. Illustrative examples center on assemblies of bare fuel rods with grid type spacers of liquid metal cooled fast reactors. (INIS)

42647 LAMINAR FLOW IN ROD BUNDLES. Rehme, K. (Kernforschungszentrum, Karlsruhe, Ger.). pp 130-3 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

The stationary, incompressible, laminar flow along parallel rod bundles is calculated. The Poisson equation is solved numerically by the difference method using a two-dimensional diffusion code. Distributions of the velocity and of the wall shears and the loss of pressure are determined as a function of the geometrical parameters for various bundle configurations. For larger numbers of rods, the flow cross section is subdivided into subchannels for which geometrical factors are calculated. A comparison of these geometrical factors of subchannels with measured values for the entire laminar flow shows good agreement. (INIS)

42648 TEMPERATURE FIELDS IN FUEL, CLADDING, AND COOLANT OF FUEL ELEMENTS WITH SYMMETRICAL AND ASYMMETRICAL GEOMETRY. Hofmann, F. (Kernforschungszentrum, Karlsruhe, Ger.). pp 134-7 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Geometrical deviations of fuel rods from their nominal position in the rod bundle that arise from production tolerances or from operational conditions have a strong effect on the velocity and temperature distributions in the coolant, cladding and fuel. This effect is studied by means of a geometrical model. Numerical results are presented for a special sodium-cooled fuel rod bundle. (INIS)

42649 CONVECTIVE HEAT TRANSFER FOR ROD BUNDLES WITH AXIAL FLOW. Markoczy, G. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). pp 142-5 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

Average and local heat transfer numbers were measured for 37 different rod positions in fuel rod bundles with hexagonal and circular configurations. The mean values can be represented by a dimensionless function that is the ratio of the mean Nusselt number of the rod to the Nusselt number for circular pipe geometry. The theoretically predicted properties of this function are in good agreement with the measurements. For the calculation of the distribution of the heat transfer number over the rod circumference, an analytical method has been developed and compared with measured values. (INIS)

42650 INVESTIGATIONS ON COOLANT VELOCITY AND COOLANT THROUGHPUT MEASUREMENTS FROM CORRELATED THERMOELEMENT SIGNALS. Mika, C.; Raes, K.-H.; Stegemann, D. (Technische Univ., Hanover). pp 391-4 of Reaktortagung, Bonn, 1971. Bonn; Deutsches Atomforum E. V. (1971). (In German).

From Reactor meeting; Bonn, Germany (30 Mar 1971). See CONF-710346.

A procedure has been developed for the calculation of the flow rate which uses the relationship of signals from thermoelements arranged in series in the heated flow. (INIS)

GENERAL

Law

42651 POSITIVE RESULTS FOR THE FRG OF A RATIFICATION OF THE PARIS CONVENTION ON THIRD PARTY LIABILITY IN THE FIELD OF NUCLEAR ENERGY. Strohl, P. (European Nuclear Energy Agency, Paris). Energiewirt. Tagesfragen; 21: No. 6, 309-20(1971). (In German).

All the provisions contained in the Paris Convention on Third Party Liability in the Field of Nuclear Energy are discussed and compared with those that are valid at present in the FRG. The advantages that would be brought about by internationally accepted agreements concerning nuclear liability are outlined. Referring to the extensive activities of the FRG in the nuclear field, the author urges for the Paris Convention to be ratified by the FRG. (INIS)

42652 GOETTINGER ATOMRECHTSKATALOG. GOETTINGER ATOMIC ENERGY LAWS CATALOG. VOLUME 22. Goettingen, Ger.; Institut fuer Voelkerrecht der Universitaet Goettingen (1971). 519p. (In several languages).

This volume is devoted to the federal laws and regulations of the United States pertaining to the peaceful uses of nuclear energy, and to the international treaties in this field to which the United States is a signatory. For easier reference the part on legislation has been subdivided into laws and concurrent resolutions, executive orders and organization plans, regulations of the Atomic Energy Commission, other regulations, agreements of the AEC with States, and interstate cooperation, whereas the international treaties are grouped into bilateral and multilateral agreements. Within each subdivision the material is listed in chronological order. Wherever possible several sources are indicated for each entry, and a careful system of references helps the reader to find his way through the complexity of the subject, enabling him to easily ascertain the present state of legislation and of treaties as well as to perceive their historical development. The present volume is to be followed by several volumes on State legislation in the same field. (auth)

Miscellaneous

42653 (ACRH-1000-330) SENIOR QUALIFICATION FOR LEADERS IN MEDICAL PHYSICS: IS THERE A NEED FOR A SENIOR QUALIFICATION? Lanzl, Lawrence H. (Chicago Univ., Ill. Dept. of Radiology. Argonne Cancer Research Hospital, Chicago, Ill.). Apr 1972. Contract AT(11-1)-69. 5p. (CONF-720435-1). Dep. NTIS.

From Seminar on training and education in medical physics; Kiel, Germany (10 Apr 1972).

42654 (BARC-600) ADSORPTION OF CRESOLS ON MOLYBDENITE. Viswanathan, K. V.; Majumdar, K. K. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 14p. Dep. NTIS (U. S. Sales Only).

42655 (BARC-603) ADSORPTION OF LONG CHAIN ELECTROLYTES AT THE SOLID-LIQUID INTERFACE. PART III. WOLFRAMITE-WATER SYSTEM. Viswanathan, K. V.; Majumdar, K. K. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 15p. Dep. NTIS (U. S. Sales Only).

42656 (BARC-605) ADSORPTION OF LONG CHAIN ELECTROLYTES AT THE SOLID-LIQUID INTERFACE. PART IV. BERYL-WATER SYSTEM. Sarkar, R. C.; Viswanathan, K. V.; Majumdar, K. K. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 14p. Dep. NTIS (U. S. Sales Only).

42657 (BMI-171-146) AMCHITKA BIOENVIRONMENTAL PROGRAM. AERIAL AND GROUND-TRUTH PHOTOGRAPHY FOR ENVIRONMENTAL SURVEILLANCE OF AMCHITKA ISLAND, ALASKA. Annual Progress Report, July 1, 1970-June 30, 1971. Stephan, Joachim G. (Battelle Columbus Labs., Ohio). May 1972. Contract AT(26-1)-171. 25p. Dep. NTIS.

42658 (BNL-16215) LOGIC-IN-MEMORY ARCHITECTURE FOR LARGE-SCALE-INTEGRATION TECHNOLOGIES. Peskin, A. M. (Brookhaven National Lab., Upton, N. Y.). [1971]. 25p. (CONF-720501-3). Dep. NTIS.

From Spring joint computer conference; Atlantic City, NJ. (16 May 1972).

42659 (BNL-16851) ECOSYSTEMS AND WORLD POLITICS. Woodwell, George M. (Brookhaven National Lab., Upton, N. Y.). [1972]. 10p. (CONF-720621-1). Dep. NTIS.

From United Nations Conference on Human Environment; Stockholm, Sweden (5 Jun 1972).

42660 (BNL-tr-485) MINIMUM COOLANT REQUIREMENT FOR PRECOOLING OF CRYOGENIC EQUIPMENT. Keilin, V. E.; Klimenko, E. Yu.; Ozhogina, V. K. (Institut Atomnoi Energii, Moscow (USSR)). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report IAE-2085. 8p. Dep. NTIS.

42661 (CGS-746-128) ALEUTIAN SEISMIC PROGRAM. SEISMOLOGICAL BULLETIN, NOVEMBER 1971. (National Oceanic and Atmospheric Administration, Rockville, Md. Environmental Research Labs.). Jun 1972. Contract AT(29-2)-746. 75p. Dep. NTIS.

42662 (COO-3158-6) ON THE STRUCTURE OF HIGH-ANGLE GRAIN BOUNDARIES WITH PARTICULAR REFERENCE TO A RECENT PLANE MATCHING APPROACH. Balluffi, R. W.; Schober, T. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). 11 May 1972. Contract AT(11-1)-3158. 11p. Dep. NTIS.

42663 (CTC-54) SPLINE-IN-TENSION WITH UNEQUAL SPACING OF INTERVALS. Pritchard, T. E. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). 7 Jun 1972. Contract W-7405-eng-26. 43p. Dep. NTIS.

42664 (IS-T-506) LANGMUIR VAPORIZATION TECHNIQUE FOR LIQUID PHASE VAPOR PRESSURE AND PARTIAL PRESSURE MEASUREMENTS. LEAD AND INDIUM-LEAD SYSTEMS. Walter, Kenneth Leo (Ames Lab., Iowa). May 1972. Contract W-7405-eng-82. 179p. Dep. NTIS.

Thesis.

42665 (IS-T-532) EFFECT OF ELECTROTRANSPORT ON THE SOLIDIFICATION OF SOME TIN-BISMUTH AND TIN-LEAD ALLOYS. Warner, Jairus Charles (Ames Lab., Iowa). May 1972. Contract W-7405-eng-82. 185p. Dep. NTIS.

Thesis.

42666 (JUL-829-FF) QUASI-ELASTIC SCATTERING OF NEUTRONS FOR INVESTIGATION OF UNPERIODIC MOVEMENT OF ATOMS IN LIQUID SELENIUM. Kollmar, A. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerperforschung). Jan 1972. 72p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen (West Germany).

42667 (JUL-830-RX) APPARATUS FOR POLARIZING NEUTRONS AND NEUTRON DIFFRACTION ANALYSIS OF THE SYSTEM $DyXO_4$($X = P,V,As$). Schaefer, Wolfgang (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). Feb 1972. 114p. (In German). Dep. NTIS (U.S. Sales Only).

Thesis. Submitted to Bonn Univ. (West Germany).

42668 (KFK-1536) ALGORITHMS FOR PROCESSING OF TREE STRUCTURES AND THEIR USE IN ICES. Schumann, U.; Schlechtendahl, E. G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Jan 1972. 59p. (In German). Dep. NTIS (U. S. Sales Only).

42669 (LA-tr-72-14) FLOW-THROUGH FLUORESCENCE CYTOPHOTOMETRY: PRESCREENING METHOD FOR CERVICAL CANCER. Sprenger, E.; Sandritter, W.; Bohm, N.; Schaden, M.; Hilgarth, M.; Wagner, D. Translated for Los Alamos Scientific Lab., N. Mex., from Beitr. Pathol.; 143: 323-44(1971). 27p. Dep. NTIS.

42670 (NIM-1401) PRESSURE DISSOLUTION OF PLATINIFEROUS MATERIALS BY THE SEALED-TUBE TECHNIQUE: LABORATORY METHOD NO. Pt 78/2. Mallett, R. C.; Breckenridge, R.; Palmer, Ildiko; Dixon, K. (National Inst. for Metallurgy, Johannesburg (South Africa)). 22 Mar 1972. 13p. Dep. NTIS (U. S. Sales Only).

42671 (ORNL-4777) AN ALGORITHM FOR THE CONSTRUCTION OF "D-OPTIMAL" EXPERIMENTAL DESIGNS, AP-

PLIED TO FIRST-ORDER MODELS. Mitchell, T. J. (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 216p. Dep. NTIS.

42672 (ORNL-tr-2626) ANALYSIS OF URETHANE PREPOLYMERS BY HIGH RESOLUTION NMR. Kobayashi, Kousuke; Kurihara, Kenji; Hirose, Kazutoyo. Translated by H. Kubota (Oak Ridge National Lab., Tenn.), from Kogyo Kagaku Zasshi; 73: 1664-7(1970). 16p. Dep. NTIS.

42673 (ORO-1637-22) ORIGIN AND FATE OF THIOCYANATE ION IN METABOLISM. Final Report, May 1, 1954–February 29, 1972. Wood, John L. (Tennessee Univ., Memphis. Dept. of Biochemistry). 1972. Contract AT(40-1)-1637. 13p. Dep. NTIS.

42674 (ORO-2690-12(Pt.A)) PROPOSED BUDGET. Annual Report No. 12, Part A: September 1, 1971–August 31, 1972. (Florida State Univ., Tallahassee. Inst. of Molecular Biophysics). 1 Jun 1972. Contract AT(40-1)-2690. 35p. Dep. NTIS.

42675 (ORO-3018-96) PHYSICO-CHEMICAL STUDY OF SOME AREAS OF FUNDAMENTAL SIGNIFICANCE TO BIOPHYSICS. Annual Report, 1971–1972. McGlynn, S. P. [(Louisiana State Univ., Baton Rouge. Dept. of Chemistry)]. 15 May 1972. Contract AT(40-1)-3018. 30p. Dep. NTIS.

42676 (ORO-4199-1) THEORETICAL RESEARCH ON THE STABILITY OF THERMALLY STRATIFIED VISCOUS PARALLEL FLOW. Progress Report, March 1, 1971–May 31, 1972. Gage, Kenneth S. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Contract AT(40-1)-4199. 10p. Dep. NTIS.

42677 (ORO-4254-2) BIOGEOCHEMISTRY OF A RESERVOIR ECOSYSTEM. Report No. 3, September 1, 1971–June 1, 1972. Varga, Louis P.; Toetz, Dale W.; Dorris, Troy C. (Oklahoma State Univ., Stillwater). 1972. Contract AT(40-1)-4254. 37p. Dep. NTIS.

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Thesis.

42679 (SC-DR-720330) ESTIMATION OF SPECTRAL SPREADING IN NONLINEAR RF AMPLIFIERS. Aronson, Eugene A. (Sandia Labs., Albuquerque, N. Mex.). May 1972. 26p. Dep. NTIS.

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Thesis.

42681 (SRO-643-4) CHANGES IN RIBOSOMAL ACTIVITY DURING EXCISED INCUBATION OF CARROT ROOT DISKS. Lin, C. Y.; Travis, R. L.; Chia, L. S. Y.; Key, Joe L. (Georgia Univ., Athens. Dept. of Botany). [1972]. Contract AT(38-1)-643. 20p. Dep. NTIS.

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From ninth international congress of gerontology; Kiev, USSR (2 Jul 1972).

42683 (UCRL-51107(Suppl.)) REACTION HISTORY DATA REDUCTION AND PROCESSING. Gathers, G. R. (California Univ., Livermore. Lawrence Livermore Lab.). 18 May 1972. Contract W-7405-eng-48. 34p. Dep. NTIS.

42684 (UCRL-73741) PDP-8 GRAPHICS ON A STORAGE DISPLAY SCOPE. Uber, Donald C. (California Univ., Livermore. Lawrence Radiation Lab.). 25 May 1972. 7p. (CONF-720516-7). Dep. NTIS.
From Digital Equipment Computer Users Society spring symposium; Boston, MA. (11 May 1972).

42685 (UCRL-Trans-10618) ELECTROCHEMISTRY. Herrmann, C. C.; Lamy, C.; Malaterre, P. Translated for Univ. of California Lawrence Livermore Lab., Livermore, from Compt. Rend., Ser. C; 273: 1593-6(1971). 7p. Dep. NTIS.

42686 (UJV-2789-P) MINIMUM PENALTY ESTIMATE. Kovanic, P. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 27 Jan 1972. 26p. Dep. NTIS (U. S. Sales Only).

42687 (US-IBP-72-1) ABSTRACTS: US/IBP ECOSYSTEM ANALYSIS STUDIES. Volume II, Number 2. Ferguson, N. (ed.) (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 78p. Dep. NTIS.

42688 (WAPD-TM-963) SHLOG: FORTRAN PROGRAM TO PROVIDE GENERAL TECHNICAL DATA FUNCTIONS. Reference Manual. Bohl, H. Jr. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan 1972. Contract AT-11-1-GEN-14. 147p. Dep. NTIS.

42689 EDDY-CURRENT DISTANCE GAGE (8 Aug 1971) (Engineering Materials). (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). (CAPE-2211).
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